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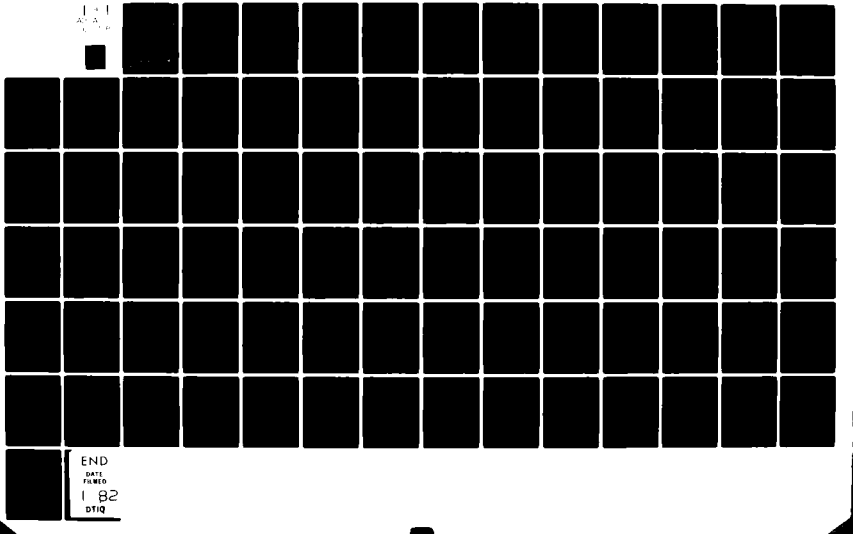

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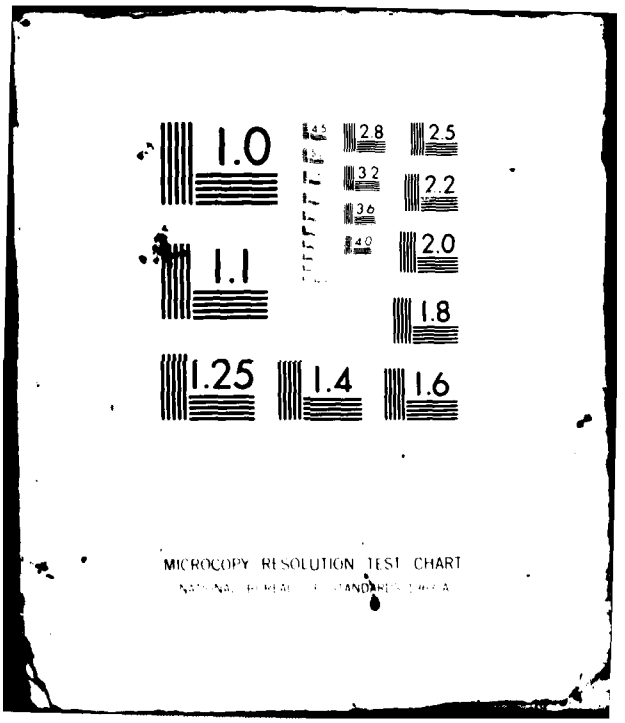
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FEASIBILITY STUDY OF SHORELINE PROTECTION AND LAKE LEVEL REGULATION FOR

RECONNAISSANCE REPORT

VOLUME 1 - MAIN REPORT

U.S. ARMY CORPS OF ENGINEERS
ESSAYONS
BUFFALO DISTRICT

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report identifies problems and needs along the United States shoreline of Lake Ontario associated with shore erosion and coastal flooding. The report includes a survey of existing conditions including those associated with the natural and human environment. Alternatives are formulated to address the needs and include lake level vegetation and standard structural and nonstructural shoreline protection measures. Significant flood and erosion areas are identified based on dollar damages and the feasibility of protection considered based

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on the costs of protection. Several areas were identified where shoreline protection may be feasible.

Feasibility Study Of Shoreline Protection

And

Lake Level Regulation For Lake Ontario

RECONNAISSANCE REPORT

MAIN REPORT

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INTRODUCTION

During the period 1972 through 1976, the Great Lakes basin experienced a period of abnormally high precipitation which resulted in high lake levels. The highest levels for Lake Ontario during this period were during 1973, which coupled with a major storm on 17-19 March 1973, inflicted most of the riparian damages sustained during this 4-year period. In addition to damages to shoreline property owners, there allegedly were undetermined amounts of damage to the natural environment. In the eyes of the riparian and environmental interests, those high lake levels and resulting damages were experienced to the benefit of power and navigation interests. They believed that their losses could have been minimized via lake level regulation. Thus, the present plan of regulation, Plan 1958-D, came under scrutiny. This provided the impetus for authorization of this study.

Study Authority

In 1976, the Congress of the United States passed the Water Resources Development Act. Section 180 of that Act, referred to as the Lake Ontario Protection Act, directed the Corps of Engineers to, "develop a plan for shoreline protection and beach erosion control along Lake Ontario." It further directed that the report shall include the following:

- recommendations on measures of shoreline protection;

. proposals for equitable cost-sharing; and

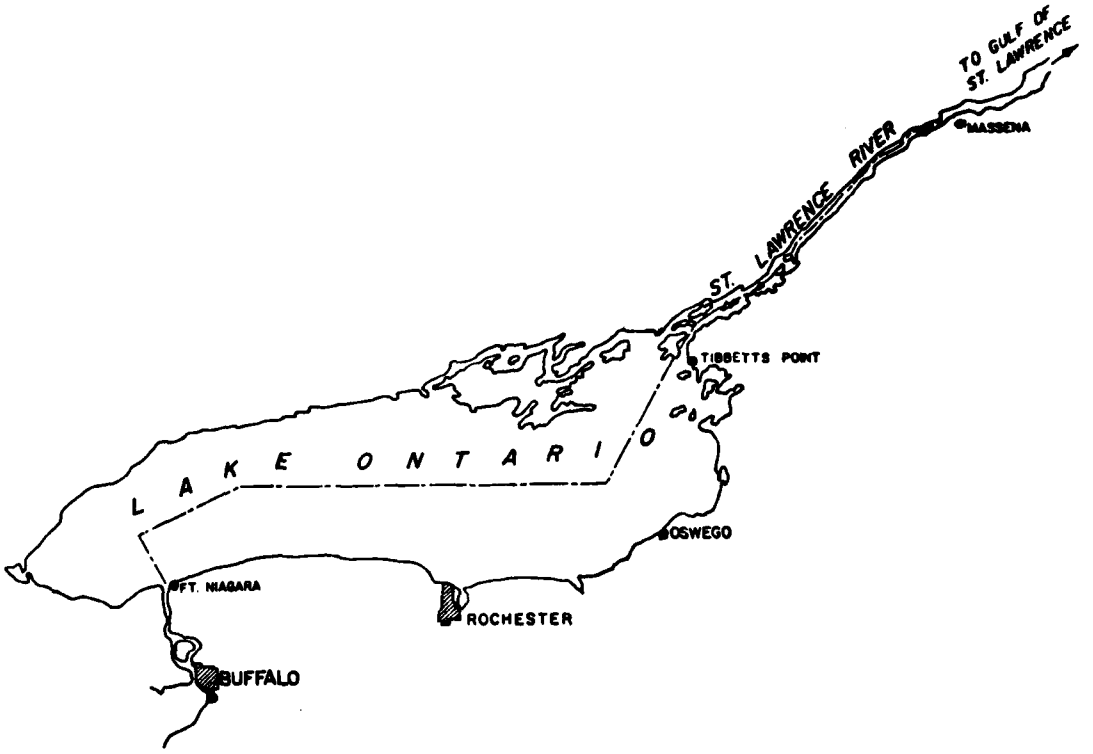
. recommendations for regulating the level of Lake Ontario to assure maximum protection of the natural environment and to hold shoreline damage to a minimum.

Recommendations on measures is interpreted to mean a feasibility investigation of all structural and nonstructural measures which would result in protection to the shoreline. The authorization specifies both beach erosion control and shoreline protection. In full consideration of testimony given to the Subcommittee on Water Resources of the United States Senate relative to S.3548, beach erosion control and shoreline protection is interpreted to mean both public and private shoreline relative to erosion and flooding due to lake levels. This is a departure from the traditional role of the Federal Government, that being only beach erosion control of public lands or lands from which public benefit is derived. This interpretation conforms with Congress's second direction relative to cost-sharing recommendations. Because Congress addressed the issue of cost-sharing in its direction and specifically mentioned "equitable," it was mindful that Section 180 was addressing an area which was nontraditional and not covered by existing cost-sharing statutes, namely the subject of erosion of private property.

The study is being conducted by the Buffalo District of the U.S. Army Corps of Engineers and is entitled the Lake Ontario Shoreline Protection Study.

Scope Of The Study

In consideration that the direction for the study was given unilaterally by the U. S. Congress, the area of problem investigation is restricted to the U. S. shoreline of Lake Ontario from Ft. Niagara at the mouth of the Niagara River to Tibbetts Point at the beginning of the St. Lawrence River. The study area will be expanded to include all of Lake Ontario and the St. Lawrence River when assessing impacts so as to best portray all impacts of alternative plans.



Study Area

Focus of the study will be directed at the problems of the U. S. shoreline which relate to the study authority, namely, shoreline erosion and inundation. Other water and related land resources problems and needs of the shoreline will be addressed in conjunction with or as a consequence of solutions for shoreline erosion and flooding.

There are basically two aspects of shoreline problems. The first aspect is associated with the problems as they relate to existing developments, i.e., existing damages to the shoreline and structures. The second aspect

relates to the future nature of the problems, i.e., continued development in erosion and floodprone areas. To be responsive to Congressional direction and to truly provide a plan for shoreline protection, the study will address both of these aspects by providing recommendations relative to existing and future development.

The study and the scope and breadth of its investigation will be conducted with full consideration of the limitations on implementation of various measures. Detail will be given to those alternative plans which can be authorized as a direct result of this study. Those plans, such as associated with lake level and land use regulation and/or requiring further study by an implementing authority, will receive a lesser degree of detail. This is not to say that they will receive lesser attention when developing alternative plans. In consideration of the number of possible alternatives and a limitation of study funds, those alternatives which can be directly implemented as a result of this study will receive the detail and analysis necessary for definitive selection and recommendation.

Study Participants And Coordination

As the accountable official for the conduct of the Lake Ontario Shoreline Protection Study, the District Engineer, Buffalo District, assumes full responsibility and control for the accomplishment of all aspects of the study to include its conclusions and recommendations.

During this initial stage of the study, Stage 1 - Reconnaissance Study, an interdisciplinary team of Buffalo District staff was utilized. Two Contractors were also utilized to augment this expertise. The U.S. Fish and Wildlife Service, NYS Department of Environmental Conservation, NYS Coastal Zone Management Program, and NYS Office of Parks and Recreation have also provided valuable inputs to the development of this report.

The study has been coordinated with the various international, Federal, State, regional, and local agencies, organizations, and the general public.

A letter of initiation was sent to political representatives, agencies and organizations informing them of the study and its intent. Meetings with various agencies have also been held. Additionally, two coordination and advisory committees have been established. The first is the Interagency Coordination Committee which was established to coordinate the Lake Ontario Shoreline Protection Study and the St. Lawrence Seaway-Additional Locks Study with the member agencies, and to coordinate the programs of the member agencies. The second committee, Citizens Advisory Committee, was established as an advisory committee and to serve as a sounding board of the views, preferences, issues, and priorities of the citizens along the Lake Ontario shoreline. Its members represent the riparian and recreational interests. Membership is made up of two members from each of the shoreline and St. Lawrence River counties, except for Cayuga County, which because of its comparatively short shoreline, has only one member. Each member is appointed to the Committee by the U. S. Congressional Representative for the particular county.

Due to the unilateral nature of the study, coordination with Canada has been restricted. Such coordination will be accomplished through Buffalo District's activities on various IJC working committees.

Other Related Studies

Being the largest freshwater resource in the world, the Great Lakes have received much study over the years. This is especially evident in recent years with the development of programs which focus on the societal/water resource interface or interrelationship. Programs such as erosion control have developed as a result of the resource's impact upon man and his desire for development. Other programs, such as the Coastal Zone Management Program, strive to understand man's impact on the resource and to manage his development to provide a mutually acceptable relationship in the future. Of the many programs which have or are addressing the Great Lakes, there are a few which are specifically related to the Lake Ontario Shoreline Protection

Study either directly or indirectly. The following is a listing of these programs, both of Corps and of other agencies.

- U. S. Army Corps of Engineers Programs or Studies

  - Big Sandy Creek - Mexico Bay, NY (Little Salmon River)
  - Great Lakes - St. Lawrence Seaway Navigation Season Extension Program
  - Great Lakes Shoreland Damage Study
  - National Shoreline Study
  - Olcott Harbor, NY
  - Port Ontario Harbor, NY
  - St. Lawrence Seaway-Additional Locks Study

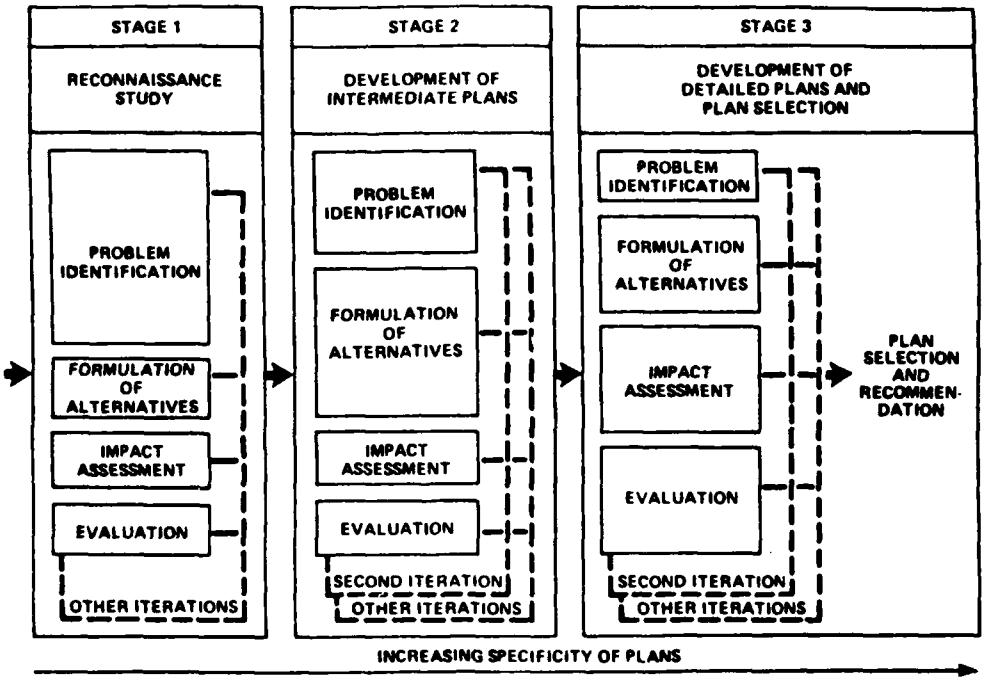
- Programs of Other Agencies

  - Great Lakes Basin Framework Study
  - Great Lakes Basin Plan
  - International Great Lakes Diversions and Consumptive Uses Study
  - International Lake Erie Regulation Study
  - New York State Coastal Zone Management Program
  - Pollution from Land Use Activities (PLUARG)
  - Regulation of Great Lakes Water Levels
  - Sea Grant Program
  - Studies to Improve the Regulation of Lake Ontario

The Report And Study Process

The Lake Ontario Shoreline Protection Study is being conducted in accordance with guidelines set forth by Principles and Standards for Planning Water and Related Land Resources as established by the Water Resources Council in 1973 and revised 14 December 1979. This study will utilize the multiobjective planning framework established by the Office of the Chief of Engineers, U. S. Army Corps of Engineers, and published in the Code of

Federal Regulations, Title 33, Part 290. This framework, in the form of Corps regulations sets forth guidance for conducting feasibility studies for water and related land resources consistent with the previously stated requirements of P&S.



Planning Process

This process involves three separate stages of plan development: development of a Plan of Study, development of intermediate plans; and development of detailed plans utilizing the four functional planning tasks of problem identification, formulation of alternatives, impact assessment, and evaluation.

The services of an Architect/Engineer firm will be contracted to conduct all phases of Stage 2 and Stage 3 with the exception of fish and wildlife studies. These latter studies will be conducted by U. S. Fish and Wildlife Service under an Interagency Agreement between the Corps and USF&WS.

The results of each stage of study development will be documented and presented in a report format at the end of each stage. These reports will be furnished to the public and other agencies for review and comment along with serving as internal management documents.

The first report, presented herewith, is the Reconnaissance Report which reflects the results of Stage 1 in the study process. It sets forth the justification for the study, documents the findings of the tasks undertaken to date, and establishes a program for managing the study. This report is also the basis for review and approval of completed and future study efforts by higher authority. The Main Report is presented in a concise and abbreviated format to enable condensed review. Appendices are provided to present more detailed discussions of respective topics.

Results of Stage 2 and Stage 3 will be presented in the Preliminary Feasibility Report (PFR) and the Final Feasibility Report (FFR), respectively. These reports will present the development of plans, and the assessment and evaluation of their impacts. The specificity of the reports increases as the study progresses towards completion. The FFR and its recommendations is subject to reviews by the Board of Engineers for Rivers and Harbors, the Office of the Chief of Engineers, the Governor of the State of New York, Secretaries of the various prescribed Federal agencies, Secretary of the Army, the Water Resources Council, Office of Management and Budget, and finally, the Congress.

The National Environment Policy Act (NEPA) of 1969 requires Federal agencies to assess and document the effect of proposed actions on the environment in an Environmental Impact Statement (EIS). In compliance with this

requirement, if the study recommendations so warrant, an EIS will be prepared in conjunction with the study report and included in the final report for agency and public scrutiny and comment.

PROBLEM IDENTIFICATION

During Stage 1, the major emphasis of study efforts was placed on the identification of problems, needs, and opportunities associated with the water and related resources of the U. S. shoreline of Lake Ontario. The identification of problems and needs consists of analyzing existing and future conditions, as identified in Sections 2 and 3, previous studies along the shoreline, the concerns of the public, and previously identified resource management problems. This analysis is guided by the national policy for water resource planning. This policy states that Federal and Federally assisted water and land resource management activities be planned toward achieving National Economic Development (NED) and Environmental Quality (EQ).

National Objectives

The overall purpose of water and land resource planning and development is the promotion of the quality of life. This is done by reflecting societal preferences. Through many and varied laws and actions, the Congress and the President have defined the objectives or goals which guide water and land resource planning. These goals are defined by the Principles and Standards for Planning Water and Related Land Resource (P&S), which were established by the Water Resources Council. It reflects national priorities for management of the nation's water and land resources by providing that the planning for

their development and management be accomplished by enhancing the two co-equal goals or objectives. The first is National Economic Development (NED) which promotes the quality of life by increasing the value of the Nation's output of goods and services, and improving national economic efficiency. The second goal or objective is Environmental Quality (EQ) which promotes the quality of life by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. These two goals serve to guide the entire planning process; therefore, the identification of problems, needs and oportunities, as well as the formulation of plans and the evaluation of their impacts must be done with full recognition to attaining national economic development and environmental quality.

Previous Studies

Previous studies of the Lake Ontario shoreline have been reviewed with a view to defining previously identified problems and needs. The studies listed below relate to erosion and flooding, the main impetus for this study.

Beach Erosion Control

- Beach Erosion Control Study of New York State Parks on Lake Ontario
  - Selkirk Shores State Park
  - Fair Haven State Park
  - Hamlin Beach State Park
  - Braddock Bay State Park

- Beach Erosion Control Study of the South Shore of Lake Ontario
  - Fort Niagara State Park
  - Goldin Hill State Park
  - Fourmile Creek State Park

- Niagara County, New York, Beach Erosion Study

- Great Sodus Bay, NY - Section 111 Reconnaissance Report for Shore Damage Attributable to a Federal Navigation Project

- Durand-Eastman Park, Rochester, NY

Flood Control

- Operation Foresight 1973 - 1974

Public Concerns

In August 1979, a series of five facilitated workshops were conducted along the shoreline of Lake Ontario. These workshops were conducted under contract with Great Lakes Tomorrow, an international citizens organization. They were held at Watertown, Mexico, Rochester, Irondequoit, and Wilson, NY. The primary purpose of these workshops was to identify issues, concerns, and problems relative to the water and related land resources of Lake Ontario, the management of those resources, and the Lake Ontario Shoreline Protection Study itself.

Participants at the workshops identified issues and concerns, and voiced questions they felt should be addressed in the study. A great deal of the concerns were relative to lake level regulation and addressed such issues as their present management, ways of improving regulation and representation on the International St. Lawrence River Board of Control. They also provided specific information regarding socio-economic and environmental factors for consideration. Potential alternative actions to be explored during the study were suggested, as were suggestions for future public participation during the study.

This input by the public has been supplemented by workshops which were conducted during June 1980. This latter set of workshops, because of their orientation, will be reported on in Stage 2. Public input from both sets of workshops has assisted in identifying problems and needs of the shoreline,

and will serve to focus studies, especially during Stage 3, which will be necessary to satisfy the publics' concerns and provide for a good assessment of impacts. Public input will also serve to direct the formulation of alternative plans during Stage 2 and 3, such that the final plans will be responsive to the publics' priorities and needs.

Existing Conditions

An accurate and comprehensive environmental, social, and economic resource data base is essential to effective planning for development of water resources. Paramount to this data base development, is the early identification of existing conditions. This data base is then refined throughout the study giving a rational basis for assessment and evaluation of likely consequences of alternative plans and for finally selecting a plan of action for recommendation. It will also furnish a basis for evaluating the need for enhancement, mitigation, or replacement measures, and to determine, as early as possible, those resources which should be preserved, enhanced, protected or approached with care.

To assist in defining this resource base, a literature search and a physical shoreline inventory was conducted by the Great Lakes Laboratory of the State University College at Buffalo. This inventory consisted of gathering economic, geologic, environmental, and engineering data for each reach.

The following is a short description or profile of existing conditions along the U. S. shoreline of and within Lake Ontario. This profile is presented from two aspects: (1) the natural environment, characterized by the physical, geological, atmospheric and biological features; and (2) the human environment, characterized by the demographic, social, cultural, and economic features.

Natural Environment

PHYSIOGRAPHY

The Great Lakes basin extends from the westerly end of Lake Superior to the Atlantic Ocean at the Gulf of St. Lawrence, a water route of more than 2,000 miles. The five Great Lakes . . . Superior, Michigan, Huron, Erie and Ontario . . . with their connecting channels and Lake St. Clair represent the largest body of fresh water in the world. They have a total water surface of approximately 95,000 square miles. The Great Lakes system being a chain of lakes, acts as a series of large reservoirs, connected by channels and rivers whereby each lake outflows to the next downstream lake.

Lake Ontario is the most downstream lake of the system, and therefore, receives the runoff from all the upper lakes' basins plus that of its own basin. It has the smallest drainage basin of the Great Lakes. Although it has the smalles surface area of all the Great Lakes, it is not the smallest in volume, being three times larger than Lake Erie.

As with the other lakes, Lake Ontario's depth varies irregularly. Its longitudinal bottom profile slopes gently from west to east reaching a maximum depth of 802 feet north of Sodus Bay. Continuing eastward, the bottom rises rapidly giving an asymetric longitudinal profile.

The Niagara River forms the natural outlet from Lake Erie. It provides the inflow to Lake Ontario from the upper lakes and averages about 200,000 cubic feet per second. Lake Ontario's outlet is the St. Lawrence River which flows 530 miles northeasterly to the Gulf of St. Lawrence averaging approximately 232,000 cubic feet per second at Cornwall-Massena.

TOPOGRAPHY

The Lake Ontario basin has the greatest extremes in topography of the five Great Lakes basins. It falls from more than 4,000 feet in the Adirondack Mountains to approximately 240 feet at the lakeshore. Generally,

the land is flat in Niagara and Orleans Counties. This changes to gentle-rolling hills through Monroe, Wayne, Cayuga, and western Oswego Counties. The land becomes steeper in the remainder of Oswego County, Jefferson and St. Lawrence Counties. Streams tributary to the lake have a dendritic drainage pattern with many having deeply incised valleys and have some of the larger watersheds found within the Great Lakes Basin.

GEOLOGY

Based on geomorphic criteria, the U. S. coastline of Lake Ontario can be classified into nine geomorphic units. The criteria used for this classification primarily include the shoreline configuration, physiographic and geologic nature of the bluffs, and the response characteristics of the bluffs to littoral processes. The geomorphic units include:

- Straight Lake Plain-Bluff, Type 1 - The Niagara and Orleans County shorelines are of this type. Steep bluffs up to 60-feet high in this area are subject to erosion by wave action and mass wasting processes.

- Eroding Headlands with Bay Beaches, Types 2, 5, and 7 - The shorelines of Eroding Headlands Units are characterized by sinuous shorelines with headlands skewed to the east, sandy or gravelly bay beaches, and bluffs with exposed bedrock at the base. The headland orientation and geometry may be partially controlled by the joint patterns in the bedrock. The three divisions of the Eroding Headlands Unit are mainly based on their erosional response criteria to littoral processes. Examples of each of the three types follow:

  - Eroding Headlands with Bay Beaches - Type 2
    The western Monroe County shoreline

  - Eroding Headlands with Bay Beaches - Type 5
    The western Wayne County shoreline

- Eroding Headlands with Bay Beaches - Type 7
  The western Oswego County shoreline

. Flat Drumlin and Bay Mouth Barrier, Type 3 - The shoreline is characterized by low flat drumlins with wetlands and bays on the areas between drumlins. Long narrow barriers separate the lake from the wetlands and bays. The eastern Monroe County shoreline is included in this unit.

. Eroded Drumlins, Type 4 - The highly urbanized, sandy shoreline near the mouth of the Genesee River is included in this unit.

. Eroding Drumlin and Bay Mouth Barrier, Type 6 - Extremely high (up to 150 feet) drumlin bluffs separated by marshes which are fronted by barrier beaches characterize the Eroding Drumlin and Bay Mouth Barrier shorelines. Bluffs are composed of glacial tills. Slumping and rill erosion dominate bluff erosion processes in this area.

. Barrier Island, Type 8 - The north-south oriented shoreline of Oswego and Jefferson Counties which are characterized by wide sandy beaches, long narrow barrier islands and their associated dunes are separated by narrow inlets and are included in this unit.

. Rocky Bluff, Type 9 - The high rocky, often-terraced bluffs along the deep bay shoreline of northern Jefferson County are included in this unit. Occasional wetlands and pocket beaches between headlands characterize this section of shoreline.

COASTAL PROCESSES

Significant wave action on Lake Ontario is generated by winds blowing across the water's surface. The strength and duration of the winds and the water fetch (or length of open water over which the winds can blow without obstructions) control the deep water wave height. The predominant waves during the ice-free period (1 April throught 31 December) are less than

2 feet high. Waves higher than 6 feet are more common at the eastern shoreline. High deep water waves may form during winter storms; but the influence of such waves on littoral processes is insignificant as ice formation on the shore virtually ceases any longshore transport.

The longshore component of wave energy which is responsible for longshore sediment transport (drift) varies extensively along the shoreline. A qualitative determination of the drift rate reveals that it ranges from weak to moderately strong. The drift pattern at the eastern shoreline is from south to north toward the southern end and from north to south toward the northern end, with a poorly defined nodal point in the general vicinity of the North Pond barrier. The drift direction along the southern shoreline is predominantly from west to east, but occasional drift reversals are observed. Embayments, such as Irondequoit Bay and Mexico Bay, are characterized by a local point of convergence where no longshore direction of transport dominates. Offshore transport of sediment frequently occurs at river mouths, stick-out features, and headlands. Onshore transport is rare except at the east end of Lake Ontario where long period swells transect a broad shallow offshore sand sheet.

SHORELINE

The shoreline of Lake Ontario is approximately 300 miles long. Beginning in Niagara County the shoreline is essentially straight. The shore bluffs are from 30 to 60 feet high composed of glacial deposits. The westerly 20 miles of shore are generally developed with a fringe of summer and permanent residences. The upland is agricultural. Development is more scattered along the eastern shoreline of the county. The loose bluff material of Niagara County is very erosive and open to wave attack, frost action, seepage, and surface erosion. Beaches are narrow.

The shoreline of Orleans and Monroe Counties have a combined length of 59 miles. The shore characteristics vary considerably, from the 20 foot or higher glacial till bluffs of Orleans County to the low marshy shore found

along the shore of Monroe County. About 20 miles of the Monroe County shore west of Rochester is low marshland with barrier sand and gravel beaches separating the marshes and open ponds from Lake Ontario. The easterly 7 miles of the Monroe County shore through the town of Webster has silt and clay bluffs up to 55 feet high. The beaches along the shore of both counties are too narrow to provide much protection. There is generally a narrow sand or gravel beach perhaps up to 30 feet wide but no wide beaches, except where held by major structures such as the U. S. West Pier at Rochester Harbor. There is considerable sand in some of the bluffs, notably at Devils Nose in Hamlin Beach State Park. The bluffs are eroding over the entire length of Orleans County, where unprotected. Monroe County, which is more highly developed, has more of its shore protected. The shore of Orleans County has a fringe of residential development along a little over half of its total frontage. The remainder is mostly open space, i.e., agricultural, undeveloped, or parkland. Twenty miles of Monroe County is in residential use, about 7 miles is parkland, and the remainder is undeveloped or used for commercial and industrial purposes. Within the past 20 years, there has been a reduction in agricultural and undeveloped property and a marked increase in residential and park properties.

The shoreline of Wayne, Cayuga and Oswego Counties is approximately 80 miles long. The westerly 22 miles of the Wayne County shore, between the Monroe-Wayne County Line and Sodus Bay, have a quite continuous bluff from 10 to 70 feet high, with an average height of about 25 feet. The bluff material is mainly silt and clay. The average width of the beach is about 10 feet. The beach material is coarse gravel and shingle. Ledge rock is generally at or up to 3 feet above, lake level. The easterly 15 miles of the Wayne County shore, between Sodus Bay and Little Sodus Bay, are a series of drumlins (elongated hills of glacial till) separated by marshes that extend several miles inland along small creeks that enter the lake. The drumlins are up to 150 feet above lake level and one-quarter to one-half mile wide at their base. The material at the bluff face of the eroding drumlins is glacial till, containing from 10 to 100 percent sand and gravel. Lake Bluff, just east of Sodus Bay, and Chimney Bluff, 2 miles farther east, are two of the

highest. The latter is undeveloped and is in State park property. Beaches at the base of the drumlins are generally less than 10 feet wide. Narrow sand and gravel barrier beaches have formed across the low marsh areas or open water between the drumlins. The shore characteristics of the entire 8 miles of the Cayuga County shore, and the westerly 5 miles of Oswego County to the west city line of Oswego are similar to those in eastern Wayne County. For about 13 miles east of the mouth of the Oswego River, the shore bluffs are from 5 to 25 feet high. Rock outcrops from lake level to 10 feet or more above lake level occur within this reach. The overlying material is glacial till. Gravel and shingle beaches up to 30 feet wide also occur. From 13 miles east of Oswego to the Salmon River at Port Ontario, the shore contains occasional reaches of high ground separated by marsh areas that are fronted by barrier beaches. These beaches are similar to but less prominent and noticeable than the drumlin formations farther to the west. The remaining Oswego County shoreline north of the Salmon River is generally a barrier beach with sand dunes up to 45 feet high, separating either marsh areas or open ponds from the lake. The dunes and wide flat beaches consist of fine sand. The upland shore of Wayne County is used mainly for agricultural purposes. Fruit is the principal crop. A fringe of scattered residential developments borders the lakeshore.

The shore of Jefferson County is approximately 120 miles long between the Oswego-Jefferson County line and Tibbett's Point at the head of the St. Lawrence River. It is very uneven and contains several deep bays and prominent headlands. For 10 miles north from the Oswego County line, a barrier beach and sand dune extend in nearly a straight line, separating march areas and small ponds from the open lake. The beach and dune are composed of very fine sand, and the beach has a very flat offshore slope and is relatively stable. At the end of this 10-mile reach, the shore characteristics change abruptly. Rock outcrops at the water's edge and rises gradually to a height of about 75 feet on the west side of Stony Point. It then falls gradually, as the shore continues around Stoney Point into Henderson Bay. From Henderson Bay to the head of the St. Lawrence at Tibbett's Point, there is generally shale or limestone rock for several feet above lake level. The

rock has a few feet of earth cover containing considerable granular material. There are a few pockets of sand beach, but the beach material is mostly gravel, shingle, or ledge rock. Marsh areas occur at the inner end of some of the deep bays. About 3 of the 10 miles of barrier beach and dunes north of the Oswego County Line have been developed for summer residential use. Much of the remaining shore in the county has occasional reaches of residential development, when accessible by roads. The principal change in the last 20 years is a large increase in residential development, with a similar decrease in agricultural and undeveloped frontage.

CLIMATE

The climate regime includes four distinct seasons, with a variety of precipitation types and sources and stable month-to-month quantities. The Great Lakes themselves influence the climate by modifying continental air masses. In winter, artic air results in mean daily temperatures below freezing for 1 or 2 months. From June through October, remnants of hurricane systems may pass close to or into the Lake Ontario basin, producing heavy rains and winds.

HYDROLOGY

Lake Ontario, the most downstream of the Great Lakes, receives the runoff from all the upper Great Lakes basin. The total water supplied to Lake Ontario is the result of inflow from Lake Erie, runoff from the Lake Ontario drainage basin, precipitation on the lake surface, and groundwater inflow. Supplies from Lake Erie reach Lake Ontario in three ways. Most of this water flows via the Niagara River averaging 198,000 cfs. An additional average flow of 7,000 cfs is diverted through the Welland Canal for navigation purposes and hydropower production at DeCew Falls. About 700 cfs is diverted from the Niagara River to the New York State Barge Canal and inflows to Lake Ontario through four influent streams. Precipitation on the Lake Ontario Basin averages 34.6 inches annually of which only 15.5 inches is effective in producing the average annual net basin supply of 35,000 cfs. The difference

between the actual and effective precipitation is primarily due to evaporation losses from the lake and land surfaces. The peak runoff usually occurs during the month of April as a result of rainfall and snowmelt associated with either a saturated or frozen soil. Precipitation falling on the lake surface, approximately 19,000 cfs on the average, is a large and direct contribution to the lake and affects the lake level immediately.

Evaporation from the lake surface is an important factor in determining the amount of water, which after being supplied to the lake, is available for outflow. The lowest evaporation rate is experienced during April and May, whereas the highest rate is during the autumn. The average annual amount of evaporation from Lake Ontario's water surface is approximately 25 inches or an equivalent of 14,000 cfs. The net of all the above factors is referred to as the net total supply (NTS). The difference between it and the outflow from the lake is the change in storage or lake volume. Net total supplies for Lake Ontario during the 1900-1978 period have ranged from a maximum monthly average supply of 392,000 cfs (March 1976) to a minimum monthly average supply of 136,000 cfs (October 1934) with an average monthly supply of 240,000 cfs.

LAKE LEVELS

The levels of Lake Ontario fluctuate on a short-term, seasonal and long-term basis. Short-term changes in lake levels result from climatic conditions such as storms or pressure systems which produce a "setup" at one end of the lake. Due to the predominant wind direction, this is usually at the eastern end. Seasonal variations result from seasonality of the precipitation, runoff and evaporation. Long-term variations usually last over a period of years and result from periods of abnormal precipitation over the entire Great Lakes basin.

The maximum monthly average water level recorded on Lake Ontario for the period 1900-1978 was 248.06 feet (IGLD 1955) in June 1952, and the minimum was 241.45 feet in November 1934, both of which occurred before regulation began.

The average annual range of lake levels (difference between the annual maximum and minimum monthly averages) is 1.6 feet.

The natural regime of the Lake Ontario outlet, the St. Lawrence River, has undergone changes since 1825. These changes, which have included channel modifications and structures, were constructed for navigation and power generation. It was not until 1958, with the construction of the St. Lawrence Seaway and Power Project, that man was able to regulate the outflow of Lake Ontario.

In granting its approval for the construction of the Seaway and Power Project, the International Joint Commission, issued its Order of Approval which established the conditions within which the improvements would be designed, constructed, maintained, and operated as to safeguard, so far as possible, the rights of all interests affected by the levels of and flows from Lake Ontario. These Orders established a range of stages (242.77 - 246.77 feet) and criteria for regulation. The Commission also established the International St. Lawrence River Board of Control to monitor the operations of the project to insure compliance with the requirements of the Orders of Approval.

Since its adoption in 1963, the current operational plan for regulation of Lake Ontario outflow has been Plan 1958-D, supplemented with the Board's discretionary authority. Plan 1958-D is tailored to the supplies of the past, as adjusted, using the preproject stage-discharge curve as a basis for the rule curves, and by adjustments to the rule curve and flow specified, depending on the Lake Ontario level and the water supply. The outflows prescribed by the rule curves are then subject to certain maximum and minimum flow limitations to insure that the criteria and other requirements of the Orders of Approval are satisfied.

AIR QUALITY

New York State's existing air quality classification system is divided into four levels ranging from "Level I" - areas where the atmosphere is relatively free of pollutants - to "Level IV" - areas where the air is heavily ladened with contaminants.

In general, air quality along the Lake Ontario-St. Lawrence shoreline is classified as being Level I - except for the several following specific areas located in Niagara, Monroe, Oswego, and St. Lawrence Counties.

a. The area in the northwest corner of Niagara County, where the Niagara River enters Lake Ontario, is classified as Level II.

b. Monroe County has a large area identified as Level II air quality bordering the Lake that extends eastward from about Manitou Road in the town of Hilton, to Salt Road outside the town of Webster. This area extends southward between these two points to almost the boundaries of Monroe, Livingston, and Ontario County.

c. Oswego County has a Level II area adjacent to the shoreline in the vicinity of the city of Oswego. The western boundary of this area extends to the shoreline from approximately the intersection of the Oswego-Hannibal townlines with Route 104. Moving eastward from this line, the Level II area along the lake extends to about Klocks Road in the township of Scriba.

d. St. Lawrence County has two areas not designated as Level I. The first area located within the corporate city limits of Ogdensburg, is classified as Level II. The second area, located from about the eastern half of the village of Massena, eastward to the Massena-Franklin Counties border, is designated as Level III.

WATER QUALITY

The open water of Lake Ontario is classified "A" which is water that can be used as a source of drinking water. The near shore waters are, like the open water, "A" with the exception of the Rochester embayment ("B" -primary contact recreation), and Oswego Harbor and Black River embayment ("C" - suitable for fishing but not primary contact recreation or as a drinking water source). The lake is considered to be mesotrophic - having moderate nutrient levels. High coliform counts along the shore between the Niagara River and Eighteenmile Creek, and in the Rochester embayment has resulted in the closing of beaches. Toxic chemicals such as mirex, PCB's, pesticides, etc., remain the primary threat to the quality of the water and fish resource in the lake. In bays and wetlands, where mixing is poor, the water has a higher trophic level due to nutrients from poor waste treatment and runoff from agricultural lands.

PRIME AND IMPORTANT FARMLAND

The Lake Ontario shoreland includes some of the most productive and valuable land resources in New York State and a large portion is classified as "prime farmland." As such it warrants special consideration so that it is not committed to other irreversible uses unless such commitment is clearly in the public interest.

VEGETATION

Both terrestial and aquatic vegetation are found along the Lake Ontario-St. Lawrence River coastline. Forestland, managed agricultural fields and abandoned fields in various stages of natural plant succession are interspersed along terrestrial areas of the shoreline. The littoral zone - that marginal part of water along the immediate shoreline of islands and the mainland, that extends outward from shore to about a depth of 6-7 meters (the approximate limit of rooted vegetation) - includes important aquatic areas

containing shallow bays, tributaries and wetlands that have a variety of submergent, floating and emergent plants.

FISH RESOURCES

The Great Lakes-St. Lawrence River Basin contains a variety of fish species and subspecies, many of which entered the lakes during the Pleistocene glaciation period. Exotic species (such as the white perch) are also present in the basin system due to introduction by man - either purposely or inadvertently. These introductions, along with selective overfishing of some species, clearing of forested areas in the watershed and possibly other environmental factors, have led to significant changes in fishery resources of the basin.

Prior to the 1920's, lake sturgeon, lake herring, whitefish and walleye were among the species highly sought by fisherman. However, by the 1920's, these species declined; walleye showed gradual decline during this period. Decline of these fish species led to heavier utilization of large predatory fish such as lake trout and blue pike. Blue pike were once common at the east end of Lake Ontario, where about one-fourth of the New York commercial catch was taken. Since the 1930's, lake trout, whitefish, blue pike and lake sturgeon stocks in Lake Ontario have either been eliminated or drastically reduced, but populations of carp, white perch, smelt and alewives have increased.

The single most valuable biotic resource of eastern Lake Ontario is the areas fishery. Its numbers and variety of fish support both sport and commercial fishing enterprises. In general, the St. Lawrence-Eastern Ontario region harbors a major portion of the fisheries resources of New York State - this includes cold and warm water fish species. New York State stocked coho salmon in the Salmon River drainage in 1968 and in Lake Ontario in 1969; chinook salmon fingerlings were stocked in the Little Salmon River drainage in 1969; KoKanee salmon were introduced in the lake and in some tributaries by Ontario Province and splake were introduced in the lake by Ontario

Province in 1969. With regard to warm water fish, the ten most important fish species harvested in 1975 (based on value) were bullheads, yellow perch, American eel, white perch, rainbow smelt, sunfish, rock bass, crappies, suckers and catfish. Other species of importance to the regions' fishery include smallmouth bass, northern pike, muskellunge, white bass, largemouth bass and walleye.

Inshore areas and tributary streams provide important spawning and nursery habitat for several forage species such as alewife, slimy sculpin, rainbow smelt and minnows.

WILDLIFE RESOURCES

The array of terrestrial and aquatic environments associated with the coastal zone provide habitat to support a diverse population of mammals, birds, amphibians and reptiles. Approximately 54 species of mammals, 257 species of birds, 19 species of reptile, and 19 species of amphibians have ranges which include the Lake Ontario-St. Lawrence River area. The Federal list of threatened and endangered species indicates 1 plant, 2 mammal, 1 snail, 3 fish, and 3 bird species as threatened or endangered which have ranges that include New York State. The New York State list of protected species includes numerous plants, 3 mammals, 1 reptile, 1 snail, 1 insect, 3 fish, and 6 bird species as protected under Section 9-1503 of the Environmental Conservation Law.

Human Environment

POPULATION

The population of the eight-county area bordering the Lake Ontario and St. Lawrence River shoreline (U. S.) was 1,443,000 in 1970. Nearly half lived in Monroe County. Population of the 40 townships and three cites bordering along the Lake Ontario shoreline was 650,000, 70 percent of which

lived in the five townships and the city of Rochester in Monroe County. Monroe County also exhibited the densest population and development along the shoreline.

INCOME

Median income ranged from $8,667 in rural St. Lawrence County to $12,423 in highly urbanized Monroe County in 1969. Three of the eight shoreline counties, Monroe, Wayne and Niagara, realized median incomes exceeding the median income for Upstate New York. Those counties associated with urban areas generally enjoy higher income levels than rural counties.

HOUSING

According to 1970 census data, there were over 473,000 housing units in the eight-county area along the shoreline, of which 226,000 housing units were contained int the townships and cities along the shoreline. Four and nine tenths percent of these latter units were seasonally vacant such as beach cottages and hunting cabins. The housing value structure among the study area counties varies from the high median value of $21,800 in Monroe County to the low median values of $10,900 and $11,000 for St. Lawrence and Jefferson Counties, respectively.

LAND USE

The variation in land use along the Lake Ontario shoreline typifies a diversity of population distribution, agricultural viability, recreational potential, industrial development, and other historical characteristics that have shaped the Lake Ontario shoreline into its existing land use. For all counties along the shoreline of Lake Ontario, residential is the major land use based on the number of parcels. This varied from 64 percent in Cayuga County to 76 percent in Jefferson County. Agricultural and undeveloped land comprised the next major use followed by recreational and commercial uses. As is expected, the vast majority of parcels are privately owned varying from 83 percent in Cayuga County to 99 percent in Orleans County.

AGRICULTURE

Though farm workers constitute a relatively small percentage of the labor force for the eight-county study area (2.5 percent), land use devoted to agriculture comprises a major portion of the total land area, especially in the rural counties. The proximity to Lake Ontario serves croplands by modifying temperatures so as to retard spring budding and prolong fall growth. There is basically two agricultural regions along the Lake Ontario shoreline. The first is the Lake Ontario-Lake Erie Fruit and Vegetable Region which covers all of Niagara County and the northern portion of Orleans, Monroe and Wayne Counties. Fruits are the predominant crop near the shore although many vegetables are also grown. The Snow Belt Mixed Farming Region extends from the northern tip of Cayuga County and extends up to and through southern Jefferson County. This region is devoted mostly to dairying, but some fruits and vegetables are grown on favorable soils.

TRANSPORTATION

Two interstate highways in the proximity of the study area are I-90 (the Governor Thomas E. Dewey Thruway), and I-81. I-90 follows the east-west corridor of the railroad and canal and traverses between Buffalo, NY, and Albany, NY, connecting Rochester, NY, Utica, NY, and Syracuse, NY. I-81 is a north-south route traversing New York State from Binghamton, NY. through Syracuse, NY, Watertown, NY, and ending at the bridge to Canada near the western end of the St. Lawrence River.

NAVIGATION

Lake Ontario is an integral part of the Great Lakes-St. Lawrence Seaway System. Active deep-draft commercial port facilities in New York State on Lake Ontario and the St. Lawrence River include Rochester Harbor, Oswego Harbor, and Ogdensburg Harbor, which allow access to the system. St. Lawrence Seaway, the Great Lakes and ports, the Gulf of St. Lawrence, and the St. Lawrence River together form 2,342 miles of continuous waterway suitable

for deep-draft, ocean-going vessels. The New York State Barge Canal, which traverses the State from the Niagara Frontier to the Hudson River, allows cheap, energy-saving water transportation to almost every corner of New York State. Proximity of the Upstate New York deepwater ports to the Barge Canal System form the backbone of water-based transportation within the State.

RECREATION

The coastal boundaries of New York State with its beaches, bluffs, sand dunes, inlets, and bays provide a multitude of water dependent and enhanced activities during all seasons of the year. The recreational use of Lake Ontario is relatively small compared with the other Great Lakes. In spite of this, the Lake Ontario Shoreline is the most heavily utilized recreation area in New York State. The various recreational activities provided for by Lake Ontario contribute significantly to the State's economy with many coastal communities depending on the recreation industry for their economic existence. Over 70 percent of the recreation is provided by commercial operators. Boat marinas, launch areas, and boat rentals dominate the recreation industry. There are large amounts of shoreline beach area as well as camping facilities, especially in the Thousand Islands region.

Twelve State parks are situated amidst the bluffs and harbors of Lake Ontario. Picnicking, boating, fishing, camping, and winter sport activities prevail at these water-based facilities. Scenic areas dominate the State parks of Selkirk Shores (Oswego County). A string of 17 State parks border the eastern end of Lake Ontario and the St. Lawrence River. These State parks offer the greatest diversity of facilities and activities. Nearly all contain campgrounds and swimming beaches and many are oriented toward boating with launch and/or mooring facilities. Picnicking for day users, fishing and hunting access, and hiking trails are common throughout the parks system. Temperature and snow cover during the winter months provide excellent conditions for ice fishing, cross-country skiing, and snowmobiling.

Recreational boating is considered to be one of the major outdoor recreational industries in New York State. This activity is one of the most expensive, requiring considerable investment in equipment. Boating embraces many forms, from sailing of both cruising and day vessels through various sized powered vessels, small dinghies, rowboats, canoes, and paddle boats.

There were approximately 140 commercial and municipal boatyards and marinas with 10 or more known berthings in the shore zone boundary counties of Lake Ontario and the St. Lawrence River when inventoried in 1972.

The lack of suitable pierside moorings, and adequate number of harbors of refuge along certain areas of the coastal boundaries of New York State is a problem. Many piers now being used are not suitable for continued use because of age and badly deteriorated conditions. In other areas, marine facilities are not readily accessible to population centers.

Future Conditions

The purpose of this section is to present a look at future conditions and to assess the direction of future development of Lake Ontario resources. These future conditions serve to define a basis upon which impacts of development plans can be measured. This is commonly referred to as the "without project" condition. Future conditions also serve to identify possible problems or needs which may not be apparent when analyzing existing conditions.

As the study progresses through Stages 2 and 3, alternative future conditions will be projected. From this range of alternative futures, the one which best reflects the constraints imposed by the economic, social, environmental, and political systems, will serve as the "most probable future" for describing the "without project" condition.

The scope of Stage 1 has limited the identification of alternative futures to that of existing literature where little discussion could be found

relative to alternative projections. What follows is basically a very preliminary identification of the "most probable future" conditions along the Lake Ontario shoreline. This discussion is tempered with the knowledge that subsequent studies will refine the discussion and provide more accurate projections.

Based on OBERS projections, the major growth areas along the Lake Ontario shoreline are Orleans, Monroe, and Wayne Counties. The largest growth rates for the (1980-2030) period are expected in Wayne County, to the east of Monroe County and the Rochester SMSA. The area is probably growing as a direct influence of the growth "pull" of the SMSA. Indeed, development in this area is strongest in those counties clustered around the Rochester SMSA. The growth in population will cause corresponding growth in employment and new housing.

Per capita income for the eight-county study area is expected to increase. The highest income, projected to the year 2030, is expected to be in Monroe, Orleans, and Wayne Counties due to direct influence of the Rochester SMSA.

The future is characterized by change including increasing population, rapid urbanization, increasing productivity and affluence, and technological advances. In order to meet the pressures of a growing society, there will be an increased use of land in various activities. Residential, commercial, industrial, and recreational land uses in the coastal counties are expected to increase. This will most probably be at the expense of agriculture and undeveloped lands. Although the loss of agricultural land to more intensive uses will remain a problem, the rate of loss will slow somewhat with the creation of agricultural districts and designation of prime and important farmlands.

The coastal zone region is an ideal location for several recreational activities. Areas designated as open space which should remain as such are those areas not suitable for development. Wetlands, flood hazard areas,

areas subject to ponding, areas where bedrock is close to the surface, and areas of highly erosive soils should be preserved.

There are several plans for development of recreational sites and facilities along the Lake Ontario shoreline. In Niagara County, a recreational site is proposed for development along Eighteenmile Creek. The 70-acre area is recommended for a natural wildlife preserve. Johnson Creek, in Orleans County, has been proposed as a possible small-boat harbor site.

It is expected that wildlife resources of the Lake Ontario drainage basin will be subjected to increased adverse impacts in the future. The single, most important factor affecting wildlife resources and their habitats is human population growth and the resultant increase in land use intensity. Population increases will cause losses of wildlife habitat through the various activities that demand land-road construction, agriculture, housing developments, industrial parks, recreational areas, etc. Degrading of the quality of habitat will also occur as a result of human habitation and activities, but these effects may less conspicuous.

The future fisheries of Lake Ontario will continue to change from that which now exists. The degree and nature of change will depend upon fishery management efforts undertaken. The State of New York expects to continue to develop and maintain one of the finest salmonid fisheries in the country, in combination with an excellent warm water fishery in the lake and the St. Lawrence River.

It is assumed that, overall, the quality of Lake Ontario waters will not become degraded or deteriorate beyond existing conditions. The Federal Government's mandate to clean up the nation's water is expected to provide the impetus and necessary safeguards to protect water quality, while New York State's pure waters and environmental protection programs will ensure protection of the Lake Ontario resource base. Shoreline development by

individuals, industrial interests, and commercial enterprises may tend to negate to some extent the promise of a high quality aquatic environment. It is expected, however, that future developments will be implemented in a more environmentally sound manner than most prior developments. It is reasoned that dredge and fill activities along shorelines and tributary streams, in addition to point source effluent discharges, will be subject to more stringent requirements and regulations than are now demanded. For fish and wildlife planning purposes, it is foreseen that Lake Ontario waters will at least maintain their present level of quality.

The rapidly developing sport fishery for salmon and trout in portions of Lake Ontario is expected to continue its present trend. Lake trout populations are expected to rebound due to sea lamprey control efforts and important ongoing lake trout restocking programs.

Wildlife resources in the Lake Ontario drainage basin will continue to provide outdoor opportunities for hunting, birdwatching, photography, and related activities; however, the quality of the experience is expected to decline due to more crowding and competition from participants. In 1960 sportfishing pressure for the Lake Ontario Basin was estimated at 3.2 million angler days. This use is expected to double by the year 2020. Pleasure boating is a substantial and growing use in all areas of New York's coastal zone, especially as it relates to an expanding fisheries program.

Problems, Needs, And Opportunities

The purpose of this discussion is to identify the full range of problems, needs, and opportunities associated with the water and related resources of the Lake Ontario shoreline in U. S. territory. The problems, needs, and opportunities have been identified by analyzing existing literature and public concerns. This has been augmented by a physical inventory of the shoreline. During subsequent stages of the study the definition of these problems will become more specific as more and more is known about the shoreline, and more field data become available.

Erosion

Erosion is a natural process and its severity is a function of several factors such as water depth, wind strength, duration, orientation, fetch, and shoreline material. Although it may be an ever-occurring event, usually it manifests itself by storm-induced wave action and may become devastating when storms occur during short and long-term periods of high lake levels. By itself erosion is not a problem, but when associated with shoreline development a conflict between man and nature arises. The severity of the problem is a function of how fast erosion is occurring, the distance which will erode, and the economic value attached to the erosion loss.

One only has to look at the wind and wave climate, and the geomorphic composition of the Lake Ontario shoreline to conclude that the shoreline is erosional. Such a conclusion, when related to the amount and type of development along the shoreline, is indicative of erosion problems. Of course, this manner of such a simplified conclusion is overshadowed by the outcry of shoreline property owners about the problem.

Cognizant of the study's primary purpose which was to address erosion and flooding along the U. S. shoreline of Lake Ontario, efforts were directed at determining the areas where erosion was a problem.

Using historical aerial photographs for the period 1938 through 1979, the rate of erosion at over 400 locations was determined. This included the erosion rate of the shoreline and the bluff. Long-term retreat rates (99 years) were also analyzed. These were obtained from the literature (Drexhage, 1979). Using both short-term and long-term erosion rates, erosion hazard areas were defined using a set of criteria. Considering that the severity of erosion as a problem is a function of the erosion rate, setback distance, and economic value, an area was considered to be a "hazard area" if it met the following criteria: (1) the short-term or long-term retreat rate must be greater than 1 ft/yr, or (2) the shoreline would reach the structure in less

than 100 years due to erosion, and (3) the market value of the shoreline development was greater than $150,000/mile. The above criteria were supplemented with consideration given to areas which were environmentally, culturally, or socially significant, and to areas considered critically erosional by the NYS Coastal Zone Management Program. Using the above criteria, 46 erosion hazard areas were identified.

Flooding

Flood damages along the Lake Ontario shoreline can generally be divided into two categories:

a. Those resulting from inundation due to the level of the lake; and

b. Those resulting from inundation and impact damage from waves.

High lake levels may result from periods of high precipitation which may last for months or from atmospheric conditions such as storms and high pressure systems. The latter are usually of short duration, i.e. one or two days, and cause setup where the level of the lake rises at one end and lowers at the other. The amount of lake level rise due to a storm is a function of the strength and duration of the wind and the length of fetch. The fetch is the length of water surface over which the wind blows.

Damages due to waves may occur at any lake level, but cause their greatest devastation in conjunction with high lake levels. The storm of 17-18 March 1973 occurred during a period of high lake levels due to precipitation, whereas the storm of 5-6 April 1979 caused a damaging setup at the eastern end of the lake. In cases where development is very close to the shoreline, waves can produce damage by impacting on the structure, and by inundation resulting directly from the wave or ponding of wave upwash in low land areas.

As part of this study it was necessary to identify areas which were floodprone along the shoreline. This was done by researching areas which were identified during "Operation Foresight" and newspaper articles. These were augmented with actual structure elevations, Federal flood insurance maps, input from public workshops, and field reconnaissance. As a result of this analysis, 38 floodprone areas were identified.

Access

Development and private ownership of the shoreline provide the greatest impediment to shorefront access for the general public. This is compounded by the amount of shoreline which is inaccessible due to physical features and topography. Cliffs and steep bluffs, while providing scenic value, limit access to all but the ambitious. With property rights extending to the water, lateral access along the shore is also restricted. When access is available via roads or rights-of-way nonresidents usually find "no trespassing" signs, or where access is permitted to the shoreline, "private beach" signs deter access along the shoreline. Land use practices and location of public thoroughfares limit the visual access of the lake. Development patterns and structural designs may block the view of the shoreline or affect the landscape.

Another aspect of this problem is access to existing and future recreation facilities. Many of the public facilities such as parks, beaches, boat launching ramps are situated in suburban or rural areas which because of their location may be inaccessible to the urban public or may discourage their use. Inadequate parking facilities may also be a factor especially during periods of high use such as on holidays.

Recreation

Conflicts with other land uses cause problems for providing recreation facilities. The amount of existing shoreline, the density and type of development, and the type of recreation facility are the major components of the

conflicts in shoreline use. This is most evident in urban or suburban areas where competition for shore land is usually won by commercial and residential users who are able to compete for the high prices of such land.

Coastal processes also present problems to recreation. The littoral transport often causes sand bars to close openings to bays and creeks, preventing access by boats and presenting a hazard to navigation.

Excessive use of an area may destroy the recreational resource. This is closely related to the need for additional facilities. If additional facilities are not provided, present ones will become over used, and fragile areas, such as the dune areas and wetlands along the eastern shore, may feel the wrath of increased recreational pressures.

The growing salmonid fishery, which has been implemented by NYS Department of Environmental Conservation, has and most probably will continue to increase the need for fisherman access along the shoreline. There is also an accompanying need for boating facilities especially safe harbors-of-refuge.

Lake Level Regulation

Since its implementation in 1963, the operational plan for regulating the outflows of Lake Ontario has been Plan 1958-D, supplemented with discretionary authority. It was developed based on supplies to Lake Ontario of the past. Since 1960 there have been two periods when supplies were in excess or less than those of the past. During 1961-64 the Great Lakes experienced a drought, and during 1972-78 abnormally high precipitation occurred over the Great Lakes basin. In both cases Plan 1958-D could not cope with the conditions. The inability of the Plan to provide lake levels within the 242.8 - 246.8 foot range during these abnormal periods is a function of the river capacity and the IJC's Order of Approval.

Another problem with lake level regulation is the concern that the level of the lake or range thereof is not being managed properly because it is not

at the level desired by a specific interest. The point of contention is that each interest responds differently to the level of the lake and, therefore, it is impossible for lake level regulation to provide levels which are best for all interests all the time.

To many of the riparian interests, the high lake levels and their resulting damages were experienced to the benefit of the power and navigation interests. Their conclusion is that the members of the International St. Lawrence River Board of Control, which monitors the operation of the St. Lawrence Seaway and Power Projects, are not divorcing themselves from their agencies' interests. As such they feel the Board only represents the interests of power and navigation. It is believed to be a general consensus among riparians that in order for regulation decisions to be reflective of their interests, there must be riparian representation on the Board.

Fish And Wildlife

Fish and wildlife resources of Lake Ontario and its shoreline are recognized for their food, aesthetic, and recreational value. Their coastal habitats are important; therefore, the protection and management of the fish and wildlife resource is dependent upon conserving and/or improving these habitats. Certain habitats, because of their nature, are more significant than others and need more specific attention. The loss of these significant habitat, which may serve as breeding or nursery areas, or temporary resting sites for migratory waterfowl, may provide a greater threat to the survival of a population than certain other habitat. The loss of such significant habitats is of national and Statewide concern.

Along Lake Ontario, wetlands are the type of habitat which has been most adversely impacted. This has resulted from dredging and filling operations and associated changes in land use. The losses are usually due to agricultural, residential, and commercial development. Much of Lake Ontario's wetlands are privately owned. Although people are becoming more

aware of the value of wetlands, adequate incentives are not presently available to encourage private land owners to preserve wetlands. Removal of upland habitat for development and agriculture may also affect wetlands by altering runoff rates so that water temperatures change, and streambank erosion and sedimentation increase. Additionally, disturbance to upland and shoreline areas may silt in fishery spawning habitats. Streambank erosion and alterations of stream vegetation is very critical to the salmonid fishery, especially in eastern Lake Ontario tributaries. Lake erosion is also detrimental to the aquatic habitat. High lake levels allow larger waves in the littoral zone causing increased bottom scour and loss of valuable fish habitat. Erosion can also affect barrier beaches which protect wetlands.

Utilization of the fish and wildlife resources is hampered by access to the resource base. Public access areas are needed. Increased development and posted lands have limited hunting areas and access to streams and the lake for fisherman. Water quality not only affects the quantity of the fish and wildlife resource, but may place restrictions on its utilization, as with the Mirex contamination. Algal blooms in embayments reduce oxygen as do nutrients and waste products.

Water Quality

The water quality of Lake Ontario is generally good, being classified for the most part as "A", safe for drinking water. Toxic chemicals present the greatest threat to the quality of the water especially in relation to the lakes ecosystem. These toxic chemicals, such as PCB's, mirex, and heavy metals, although in minute quantities, are incorporated into the body tissues of aquatic organisms. Resulting restrictions on the use of organisms such as fish can in turn place an economic burden on areas where fishing plays a very important role in the economy. High eutrophication levels due to nutrients from agricultural runoff and poor waste treatment can reduce the recreational and aquatic value of certain areas such as embayments and nearshore areas. Resulting algal bloom and aquatic weeds can cause nuisance and drinking water

problems. Poor waste treatment also causes high coliform in nearshore areas which have closed several beaches along the Lake Ontario shoreline.

Unplanned Development

The development along the shoreline of Lake Ontario, for the most part, has been unplanned and uncontrolled. Barrier beaches, which play an important part in the water/land interface of the shoreline, have in places succumbed to the pressures of development. Areas such as the town of Greece and Sodus Point have resulted from uncontrolled and unplanned or inadequately planned development. Their development has been intensive and not adoptive to the rigors of the shoreline. In many cases, homes have been built within a few feet of the water's edge. Building codes have not been used to provide adequate height and setback needed to prevent damage from waves and lake levels.

Shoreline planning has failed to provide access for other uses. Parks and other recreation areas were not included in plans for much of the development which has occurred.

Much of this uncontrolled development has meant a vast loss of wetlands. The dune areas along the eastern shore have been reduced to mere beaches and areas for residential development.

Many residential areas do not have municipal wastewater treatment, therefore, private septic systems are necessary. In areas of heavy development this has contributed to water quality problems, especially in embayments. In some areas development has been so uncontrolled that they have become aesthetically unpleasing. Individual shore protection has also contributed to this.

Information

Generally, there appears to be a need by property owners for information about coastal processes and shoreline protection. There is a large number of

International, Federal, State, regional, and local agencies, providing coastal information; however, their overlapping jurisdictions and their vast number of coastal programs are confusing and sometimes frustrating to the general public, and sometimes to the agencies themselves. Also, information on such items as construction techniques for shoreline protection measures is lacking.

Shoreline residents feel that information about decisions which are continually being made regarding the outflows from the lakes or lake level regulation is unavailable to them. Some riparians feel that they see the effects of regulation, but usually well after decisions have been made. They believe that information should be readily available to them to allow them the recourse of complaint. To change things, residents have sought representation on lake level regulation bodies, especially on the International St. Lawrence River Board of Control.

In 1979, the International Joint Commission formed the Great Lakes Advisory Board which contained private citizen and agency representatives from both sides of the border. The Advisory Board was, along with other duties, to monitor levels and flows of the boundary waters. Riparians consider this new representation insufficient and believe further representation is needed.

In addition to the need for information, the second aspect of the problem is that of misinformation. This includes such things as how the Great Lakes work, the manner in which regulation is accomplished and decisions made thereof, how other interests relate to lake levels, the use of Lake Ontario's resources, etc. Misinformation may be used to reinforce a particular stand on a certain topic or issue, or to muster support to one's side. Misinformation clouds the issues and can make problem or issue resolution sometimes impossible.

Aesthetics

One of the major resources of Lake Ontario and its shoreline, and probably the most appreciated, is the aesthetics they provide. The water, waves on the shore, a scenic view, or a historic site, provide both an inherent value and augment the value of other uses, e.g. enhancing the attractiveness of an area to vacationers also increases the quality of the recreation experience. Areas such as historical sites also provide educational values.

The problems associated to the aesthetic quality of the lake and its shoreline are relative to other problems previously discussed. Visual access is limited by shoreline development and restrictions placed on public access. Public thoroughfares are sometimes miles from the shore. Utility lines and billboards can destroy a coastal scene. Unplanned development may obliterate a sand dune. Building practice may not conform to surrounding land forms. Deteriorating buildings along the shoreline may contribute to visual blight. Water quality and pollution have profound effects on aesthetic appreciation. Varying perceptions of aesthetic values and methods for defining and quantifying them have lead to resources being unsystematically inventoried. This has in turn led to their disregard in planning decisions.

Agriculture

There are two basic problems associated with agriculture along the shoreline of Lake Ontario. The first is the loss of production farmland to other uses such as residential development. This is not a problem which is isolated to the Lake Ontario shoreline, but is of national concern.

The other problem associated with agriculture is its impact on water quality. Although the significance and magnitude of agricultural activities on nonpoint water pollution is not completely known, problem areas which can be associated with them have been identified. The first is sedimentation which may result from erosion of farmlands due to poor farming practices.

This sediment is carried to the lake by tributary streams. Turbidity of the nearshore area will retard light penetration and thus, vegetative growth. Siltation of the bottom may also cover fish spawning beds. Turbidity of the nearshore area also affects the attractiveness of an area for recreation. The second water quality problem area which may be impacted on by agriculture is nutrient enrichment. Such enrichment causes eutrophication or aging of a water body. Algal blooms and aquatic weed problems affect the quality of the water for water supply, recreation, and other uses.

Constraints

Prior to defining planning objectives for the study, it was necessary to identify constraints which might impose restrictions on the planning process. Such constraints, be they legal or public policy, would be of such importance that to violate them would compromise the validity of the entire planning effort. Constraints, as defined here, also relate to factors which will or could deter the comprehensiveness and objectivity of the study.

Relating to laws and policy which will constrain the study, the New York State Coastal Zone Management Program has established policies for the State of New York relating to the coastal zone. The program is presently awaiting passage of necessary implementing legislation by the New York State Legislature. Section 307 of the CZM Act requires that Federal agencies with activities directly affecting the coastal zone or development projects within that coastal zone must assure that those activities or projects are consistent, to the maximum extent practicable, with the approved State program. Since the approval of New York State's program during the course of this study is very probable, the objectives of the study, its conduct, and results therefrom shall be consistent with and complement the New York State Coastal Zone Management Program.

As a prime objective of its program, New York State has established policies in ten areas which will serve to guide this study. These areas are:

- Aesthetics
- Agriculture
- Air Quality
- Economic Development
- Energy Development
- Fish and Wildlife
- Flooding and Erosion
- Public Access
- Recreation
- Water Quality

Other constraints serve to limit the nature in which problems and needs are addressed, or the comprehensiveness and objectivity of the study. In conjunction with the Corps' mission, which limits problems and needs of the study area to those of the water and related land resources, the study authority specifies that the study is to develop a plan of shoreline protection for Lake Ontario, cost-sharing relative to such a plan, and recommendations for lake level regulation. This essentially requires that the study provide address to these three issues concerning the problems and needs of the shoreline, i.e. those water and related land resources problems as limited by the authority of the study.

It must also be recognized that the study has been authorized unilaterally by the U. S. Congress, but is a study of a binational resource. Unilateral study authority constrains the study to the problems and needs of the U. S. shoreline. Coordination with Canada and the International Joint Commission is further constrained by diplomatic protocol. This lack of coordination with Canada will affect the detail of the lake level analysis somewhat. This will be especially evident in the assessment of Canadian impacts. The possible use of an economic model developed by the International Lake Erie Regulation Study Board may minimize this impact on the study.

The study authority limits the total cost of the study to $2,000,000. Considering the size of the study area, which is approximately 300 miles of Lake Ontario shoreline, and the number of measures available for protecting the shoreline, it will be necessary to limit the level of detail of certain aspects of the study.

Public attitude toward the study has been and most probably will continue to constrain study efforts. Many of the riparians are reluctant to discuss any aspect of Lake Ontario and its shoreline apart from lake levels and their regulation. This reluctance to fully discuss problems, alternatives and impacts, especially at workshops, constrains the discussion of all issues. It is conceivable that such reluctance may be counterproductive to their interests. If impacts of other alternatives are not properly assessed, one may appear economically, socially, or environmentally better than lake level regulation, and thus, could be the recommended plan.

Planning Objectives

The National Objectives relating to the planning and development of the Nation's water and related land resources, which were discussed previously, can be considered more understandably as national goals. These goals are National Economic Development (NED) and Environmental Quality (EQ). Study or

planning objectives are national, State, and local water and related land resource management problems and needs specific to a given study area that can be addressed to enhance National Economic Development or Environmental Quality. Planning objectives provide a means of bridging the gap between the universality of the two national goals and the specificity of the problems in a given area. While it is not possible to directly plan for enhancing NED by increasing the value of the Nation's output of goods, and improving national economic efficiency, it is possible to contribute toward these needs and NED, for example, by reducing damage due to erosion and flooding along Lake Ontario. The same can be said for contributions to EQ.

The purpose of planning objectives is to provide sufficient specificity to direct the study in a meaningful manner. These objectives will be used to guide the formulation of alternative plans. They are also used in evaluation, when it is necessary to determine the degree to which each plan fulfills the requirements of each objective as a basis for reiteration. Generally, they will become more precisely defined as the study progresses through subsequent planning stages.

The planning objectives for the Lake Ontario Shoreline Protection Study have been developed in cognizance of:

- the problems, needs, and opportunities of the United States shoreline of Lake Ontario;

- the mission of the U. S. Army Corps of Engineers relative to the planning, management and development of the Nation's water and related land resources;

- the specific issues which the U. S. Congress has directed the study to address; and

- the policy initiatives which have been promulgated by the New York State Coastal Zone Management Program.

The planning objectives have been developed to address the problems, needs and oportunites of Lake Ontario and its shoreline within a 50-year period of analysis (1990-2040). They are divided into two categories. The first are Primary Study Objectives. These objectives address the resources within the context of the purpose and intent of the study authorization; therefore, plans which are formulated must address one or more of these objectives. The second category is Secondary Objectives which address other related resources of Lake Ontario and its shoreline. These objectives will be used to refine the formulation of alternative plans such that the plans are responsive to as many other resource problems as possible with a view to optimizing contributions to NED and EQ.

The planning objectives for the Lake Ontario Shoreline Protection Study are as follows.

Primary Objectives

- Promote and/or provide flood damage reduction measures to protect the health, safety, and property of people along the shoreline of Lake Ontario.

- Promote and/or provide measures which increase soil stability to protect and prevent damage to property from erosion along the shoreline of Lake Ontario.

- Provide for use and management of shorelands and tributary uplands in ways that reflect the normal process of change affecting shoreline resources in order to preserve the natural environment.

- Conserve and/or protect land forms, soils, vegetation, water, fish and wildlife which are a part of the Lake Ontario shoreline ecosystem.

Secondary Objectives

- Enhance the availability of access sites to Lake Ontario for recreational fishing.

- Enhance the availability of access sites to Lake Ontario for use as shoreline viewing areas and protect existing sites.

- Enhance the availability of access sites to Lake Ontario for recreational boat launching.

- Provide sufficient draft for reliable access by boats to harbor areas subject to shoaling.

- Contribute to the health and safety of recreational boaters.

- Enhance the availability of beach areas available for recreational use.

- Conserve prime and important agriculture lands along Lake Ontario.

- Protect land and water areas within the coastal area of Lake Ontario for aesthetic characteristics of Statewide significance.

- Promote land and water use which maintains or improves air quality.

- Encourage the development of harbor areas for commercial and recreational navigation.

- Provide for siting of major water-based commercial, industry, and utility facilities.

- Increase the amount of coastal recreational facilities in and near urban areas.

- Contribute toward protection/preservation of cultural resources along the Lake Ontario shoreline.

- Enhance the amount of water and the head available for hydropower generation.

- Provide sufficient draft for navigation.

- Enhance the water quality of Lake Ontario for fishery purposes.

- Enhance the water quality of Lake Ontario for contact water recreation.

- Enhance the water quality of Lake Ontario for domestic consumption.

- Provide sufficient quantities of water for domestic and industrial consumption.

- Promote the utilization of Lake Ontario fish and wildlife.

- Preserve and enhance aquatic habitat for flora and fauna in Lake Ontario.

- Preserve and enhance terrestrial habitat for flora and fauna along the shoreline of Lake Ontario.

As the study progresses, these planning objectives will be continuously reanalyzed and refined as new problems and needs are identified or regional objectives change. The planning objectives will then develop into objectives which are more resource and site specific. Each plan, which is formulated in subsequent stages of the study, will be evaluated as to whether and how well it addresses these objectives. Although a plan satisfies one or several objectives, it may in fact worsen conditions relative to another objective. The evaluation of plans will serve to identify tradeoffs, in both monetary and nonmonetary terms, which would be necessary for a particular plan to be implemented. The identification of these tradeoffs will also serve in reformulating plans in subsequent study efforts to minimize negative impacts relative to the other objectives.

FORMULATION OF ALTERNATIVE PLANS

Congress has directed the Corps of Engineers to investigate: (1) the feasibility of protecting the United States shoreline of Lake Ontario; (2) proposals for equitable cost-sharing; and (3) the feasibility of regulating the level of Lake Ontario to assure maximum protection of the natural environment and to hold shoreline damage to a minimum. To help insure that the best overall plan for each of the above is developed, a range of alternative plans will be formulated based on different sets of formulation criteria and addressing at least one of the primary planning objectives identified in the previous section. Both structural and nonstructural solutions will be given equal consideration. The solutions considered will not be constrained by considering only those traditionally used by the Corps nor those within the Corps authority to implement. All plans presented at the conclusion of the Lake Ontario Shoreline Protection Study will be fully implementable and capable of being selected as the best overall plan, this will include "no action."

Management Measures

The following are management measures which have been identified relative to the planning objectives. The measures are technical and institutional means of effectuating a reduction of shoreline damage due to erosion and flooding. These measures are divided into two categories, structural and

nonstructural measures. For purposes of definition, "nonstructural measures" are actions taken directly on land, population, or property to reduce erosion and flood damage, as contrasted to "*structural measures,*" which are actions taken or improvements constructed to act directly on the water to change its direction, area of inundation, volume, stage or timing, or to dissipate its energy. Another way of looking at these definitions is that structural measures are active/corrective in that they are directed at the cause of the problem, whereas, nonstructural measures are passive/preventative in that they are directed at the recipient of the problem.

Structural Measures

- Groins
- Bulkheads, Seawalls, and Revetments
- Beach Nourishment
- Levees and Floodwalls
- Offshore Breakwaters
- Lake Level Regulation

Nonstructural Measures

- Floodproofing
- Public Policy Inducements (Tax Adjustments and Cost Sharing)
- Purchase/Easements
- Evacuation

- Flood/Erosion Insurance

- Land Management

  - Zoning
  - Subdivision Regulation
  - Building Codes
  - Ordinances
  - Permits
  - Orders

- Vegetation

Formulation And Evaluation Criteria

Policy for multiobjective planning, derived from legislative and executive authorities, establishes, and defines the national objectives for water resources planning, these being National Economic Development (NED) and Environmental Quality (EQ). It also specifies the range of impacts that must be assessed, and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated with due regard to benefits and costs, both tangible and intangible, and effects on the ecology and social well-being of the region.

The study planning process uses a framework established in compliance with the Water Resource Council's Principles and Standards for Planning Water and Related Land Resources, which requires the systematic preparation and evaluation of alternative solutions to problems, under the objectives of National Economic Development (NED) and Environmental Quality (EQ). This process requires that the impacts of a proposed action be measured and the results displayed or accounted for in terms of contriubtions to four accounts: NED, EQ, Regional Development (RD), and Social Well-Being (SWB).

The formulation and evaluation of a plan, including the screening of alternatives, must of necessity be within the context of an appropriate set of formulation and evaluation criteria. These criteria were developed to set forth the specific constraints and parameters which bear directly upon the formulation of plans.

Technical Criteria

- Alternative plans must be engineeringly feasible, practicable, and sound.

- Plans will be adequate to provide a project life of 50 years.

- Existing facilities will be utilized to the maximum extent possible.

- Plans will be consistent with the New York State Coastal Zone Management Program.

Economic Criteria

- Benefits will be derived from a comparison of the projected "without-project" conditions to the projected "with-project" conditions.

- The total beneficial contributions (monetary and nonmonetary) should exceed the total adverse contributions (monetary and nonmonetary).

- Tangible NED benefits must exceed project costs unless the deficiency is the result of NED benefits foregone or costs incurred to obtain positive EQ contributions.

- Each separable unit of improvement must provide benefits at least equal to its cost.

- Plans should contribute to an equitable land taxing structure.

- There are no more economical means, evaluated on a comparable basis of accomplishing the same purpose or purposes, which would be precluded from development if the plan were undertaken.

- Intangible benefits will be evaluated in quantified terms, where possible.

- The costs of alternative plans will be based on preliminary layouts, estimates of quantities, and price levels current at that time.

- Benefits and costs should be in comparable economic terms to the fullest extent possible.

- Economic analysis will be conducted utilizing the current interest rate determined by the Water Resources Council and a period of analysis of 50 years.

Environmental And Other Criteria

- The use of natural resources to effect implementation of a plan will be *minimized*.

- Activities attracted to the project area as the result of plan implementation should be consonant with activities of the surrounding area, and be environmentally and socially acceptable.

- Plans should maximize the beneficial and minimize the adverse effects of the project on man-made resources, natural resources, and air, water, and land pollution.

- Plans should avoid detrimental environmental effects to the extent feasible. Unavoidable adverse environmental impacts should be fully noted, analyzed quantitatively when possible and qualitatively when

not, so that knowledgeable decision making would be possible and feasible mitigating features for such effects can be included.

- A plan is acceptable only if it is supported by some significant segment of the public. Every attempt will be made to eliminate, to the extent possible, unacceptability to any significant segment of the public.

- Plans should minimize and, if possible, avoid destruction or disruption of community cohesion, injurious displacement of people, and disruption of desirable community growth.

- Plans will protect and enhance the scenic and aesthetic resources, when possible.

Plan Formulation Rationale

The rationale or methodology which will be used to formulate alternative plans during Stages 2 and 3 will be one which uses the Corps' iterative planning process. Using the primary planning objective as the impetus to formulating alternative plans, plans will be formulated to address one or more of these objectives. Considering the difference in desired results required by shoreline protection and lake level regulation, plans will be formulated independently for each result. Because cost-sharing may be a function of the type of measure associated with a plan and, considering the number of possible solutions, cost-sharing alternatives or proposals will not be formulated until Stage 3 when a more reasonable number of plans are available for analysis.

As with the other planning tasks, formulation of alternative plans is accomplished in varying degree of detail during each of the three stages of study development. During Stage 1 - Reconnaissance Study, the first step in formulating alternative plans was accomplished, that being the identification of resource management measures relative to the primary planning objectives.

A wide variety of technical and institutional means are identified which reduce erosion and flooding or reduce the damage resulting therefrom. During Stage 2, these measures are then selected for application to a specific problem area, and an alternative plan is formulated for the site specific case. Through an iterative process of problem identification, impact assessment, and evaluation, these plans are refined. In developing these plans, full consideration will be given to plans of others. Stage 3 will consider those plans which have been selected for detailed analysis and will focus on detailed formulation and impact assesment.

Principles and Standards for Planning Water and Related Land Resources (P&S), requires that, to the extent possible during the planning process, a plan which optimizes the National Economic Development (NED) contributions, and at least one plan which emphasizes Environmental Quality (EQ) contributions will be formulated. The plans which maximize these contributions will be identified as the NED plan and EQ plan. A NED plan addresses the planning objectives in a way which maximizes net economic benefits. Recognizing that environmental quality has both natural and human manifestations, an EQ plan addresses the planning objectives in a way which emphasizes aesthetic, ecological, and cultural contributions. Beneficial EQ contributions are made by preserving, maintaining, restoring or enhancing the significant cultural and natural environmental attributes of the study area. During Stage 2, candidate NED and EQ plans will be formulated and identified with the final designation of the respective plans during Stage 3. Other plans which address mixes of NED and EQ will also be formulated so as not to overlook the "best" plan. The identification of NED and EQ plans is to provide an indication of the economic and environmental tradeoff which would result if a plan other than the NED or EQ plans were selected. Although the management option of no action or letting the "without condition" occur is not considered an EQ plan, it will be considered throughout the plan formulation process for purposes of comparison and possible selection for final recommendation. Additionally, a primarily nonstructural plan will be formulated and consideration given to conservation measures.

Lake level regulation will be considered with a view to providing a "best" plan for shoreline protection with consideration given to all interests involved, i.e. power, navigation, recreation, riparian, and the environment, and a "best" plan for the riparian and environment only. The latter is in compliance with the study authority. The analysis of lake level regulation will be accomplished utilizing the following scenarios:

- The present outlet capacity of the St. Lawrence River, and the existing Orders of Approval of the IJC.

- The present outlet capacity of the St. Lawrence River, and changes to the Orders of Approval.

- Modifications to the outlet capacity of the St. Lawrence River, and the existing Orders of Approval.

- Modifications to the outlet capacity of the St. Lawrence River, and changes to the Order of Approval.

Plans Of Others

Public input into the formulation of alternative plans during Stage 1 consisted mainly of input during a series of workshops held during August 1979. Although the focus of those workshops was problem identification, some alternatives were offered. Alternatives offered included a joint U. S./ Canada widening or diking of sections of the St. Lawrence River in order to lower levels on Lake Ontario. Alternate outlets from the Great Lakes, such as diversion of water to the Mississippi and Hudson Rivers, were proposed. Hydrodynamic breakwaters about 2,000 feet offshore were proposed to check erosion and provide a means of harnessing the wave energy for producing electricity. Protection of local headlands as a means of stabilizing the shoreline was thought to be worthwhile. Structural protection using concrete V structures such as on Lake Michigan, automobiles encased in concrete, tires tied together, and jetties were also proposed.

Consideration of lake level regulation followed along the general theme of lowering the lakes. This included keeping the levels in the lower level of the permissible range (242.8 - 246.8), lowering the levels in late winter to avoid spring high levels, releasing the maximum amount of water in spring and summer, regulating the lake to its lowest level by 15 December, lowering the level on 15 June by 6 inches, dropping the level of the lake by 1 foot, and regulating to the mean of the permissible level (244.8). Attention to lake level plans also included forecasting precipitation and upper lake levels more accurately.

Nonstructural plans were also popular. Some proposals included better definition and broader coverage under the National Flood Insurance Program, the use of erosion hazard insurance, relocation of residents away from the shoreline, control of all terrain vehicles on dunes and beaches, and the use of vegetation. Plans included restrictions on the sale of property to certain users, zoning and building codes. Certain plans proposed provision for additional public access and public land acquisition through outright purchase, purchase of property as it comes on the market, or through provision for right-of-first-refusal.

Development Of Alternative Plans

During Stage 1, the formulation of alternative plans was generally limited to the identification of measures, with the exception of a preliminary evaluation of some structural measures. This preliminary evaluation or screening was undertaken to:

. determine if structural protection of the shoreline was economically viable;

. qualify the nature of erosion and flooding problems of the shoreline; and

. reduce the number of areas to be investigated in more detail during Stage 2.

The general philosophy of this exercise was to use the least cost method of structurally protecting each of the erosion and floodprone areas which had been identified. Thus, if, by using the least cost method of structural protection, being conservative in estimating the cost of protection and liberal on the estimated benefits, an area was not economically feasible to protect, it definitely would not be in subsequent stages of the study when the analysis becomes more stringent.

The selection of the best structure for each area was determined based upon its application for flood or erosion control, or both, the property elevation, the design lake level, nearshore slope, present protection, and shoreline condition. The most commonly recommended structure was the basic revetment. Seawalls in combination with revetments were recommended where property elevations were less than the minimum design crest elevation. The recommended plan of protection also took into account continuity of design within a community or hamlet. Present shoreline practices within an area were also considered in the development of the protection for an area.

The evaluation of the economic viability of structural shoreline protection was based upon the cost of the protection, the damages prevented, and additional recreational value which would be provided. The analysis used a 50-year project life and an interest rate of 7-1/8 percent. Erosion damages were determined for each area using both the short-term and long-term rates, setback distance of the development, and the market value of the land and development. Flood damages were derived from "Operation Foresight" stage damage curves which were updated to reflect 1979 prices and new construction. Curves assumed pre-"Operation Foresight" shoreline, i.e., no "Operation Foresight" protection.

The screening out of areas which are not feasible (B/C <1), was not possible during this analysis as had been anticipated. This was due to some of the simplifying assumptions which had to be made during the analysis. During the early part of Stage 2, the sensitivity of these assumptions will be analyzed, and if needed, the necessary data will be detailed to permit the screening.

IMPACT ASSESSMENT AND EVALUATION

The selection process is accomplished through the completion of two primary tasks. These tasks are "Impact Assessment" and "Evaluation." The tasks are carried out initially for all alternatives which address one or more of the planning objectives. This process is then repeated in more detail in subsequent planning stages, to again select the best of the remaining plans. This iterative impact assessment and evaluation process is continued until a single best plan is selected. One of the results of each iteration is the determination of the type and depth of further studies required to continue the selection process.

Impact Assessment

As a general guide, the impact assessment involves the identification, description, and, if possible, measurement of the effects of the different alternative plans on the base year condition to define the "with condition." It is then compared with the "without condition" to define the impact of the plan. Impact assessment provides for analyzing the significant effects of each alternative. These are the economic, social, and environmental consequences of an alternative which would be likely to have a material bearing on the decision-making process. Impact assessment requires forecasting where and when significant primary and higher order effects could result from implementing a given alternative. This determination requires analyzing and

displaying monetary and nonmonetary changes in an objective manner based on professional and technical assessment of the resources. The absence of change or no net change from the base condition could also be a significant impact in certain instances. Describing impacts does not necessarily reflect societal preferences; such preferences are determined through subsequent coordination and evaluation with Federal, State, Regional, and local agencies and citizen interests.

During Stage 1 an initial, but cursory, impact assessment was performed. This initial assessment is an early attempt to assess and evaluate potential alternative measures. At this first stage in the planning process, the assessment is based on existing available information. The objective at this point is to preliminarily identify potential impacts of measures, relative to basic and/or general social, biological, and economic criteria. The intent is to have identified impacts aid planners throughout all of the planning process by providing them with a tool to help them eventually select a plan that best solves the shoreline problems and best satisfies overall social, economic, engineering, cultural, and environmental concerns. As the study progresses, additional alternatives and/or criteria may be added and a more comprehensive social, economic, cultural, and environmental assessment will be developed.

The following is a listing of the criteria against which the alternative measures were assessed. Criteria marked by an asterisk (*) are those specifically required by Section 122 of Public Law 91-611.

Social Criteria

Population Density
Population Mobility
Housing
*Displacement of People
Transportation
*Desirable Community Growth

*Aesthetic Values
Institutional Dynamics
Health & Safety
*Community Cohesion
*Noise
Leisure & Recreational Opportunities

Cultural And Biological Criteria

Cultural Resources.

Archaeological Sites
Historical and Architecturally Significant Structures
Submerged Cultural Resources

*Natural Resources.

Wetlands
Fisheries
Wildlife
Threatened or Endangered Species
Benthos
Littoral Zone
Vegetation
*Air Quality
*Water Quality
Nekton and Plankton
Terrestrial Soils and Bottom Substrate
Topography
Federal - State-Owned Natural Areas (Existing)

Other Environmental Criteria

Erosion
Sedimentation
Water Levels and Flows
Productivity

Economic Criteria

*Revenues
*Property Values
*Public Facilities
*Public Services
*Regional Growth
*Employment/Labor Force
*Business and Industrial Activity
*Displacement of Farms

Evaluation

Evaluation is the analysis of each plan's impacts against the "without condition" and against the other plans. Whereas, impacts are identified through an objective undertaking based largely on professional analysis, evaluation determines the subjective value of these changes. This is accomplished by conducting "with and without" analysis of the alternative plans and ascribing values to the impacts based on the public's perceptions of them. The process begins by establishing the contributions of each alternative in relation to the planning objectives and the economic development of the nation and region, the social well-being of the area, and the environment. Then the response to the alternatives to specified evaluation criteria is determined. From this information, judgments will be made concerning the beneficial and adverse nature of the contributions of an alternative to establish its overall desirability. After this has been done for

each alternative, plans that do not result in an improvement over the "without" condition will eventually be eliminated from further consideration. The relative merits of each remaining alternative in comparison with the other remaining alternatives will then be established. Upon completion of this evaluation, information will surface which will be incorporated in succeeding iterations so as to more fully achieve beneficial contributions while reducing adverse contributions.

Due to the cursory nature of the impact assessment an evaluation and comparison of alternative measures was not possible. All measures will be considered during Stage 2 in formulating alternative plans.

STUDY MANAGEMENT

The Secretary of the Army, acting through the Chief of Engineers, U.S. Army Corps of Engineers, was directed by the Congress of the United States to conduct the Lake Ontario Shoreline Protection Study. The study was assigned by the Office of the Chief of Engineers to the Division Engineer, North Central. In turn, it was assigned to the District Engineer, Buffalo District, within whose District the study area lies. As the accountable official for its conduct, the District Engineer assumes full responsibility and control for the accomplishment of all aspects of the study to include its conclusions and recommendations.

Interdisciplinary Study Approach

Requirements of P&S, NEPA, and Section 122 of the River and Harbor Act of 1970, among others, demonstrate the need for an interdisciplinary planning approach to managing and developing our Nation's natural resources. Such an interdisciplinary approach has been used during Stage 1 and will continue to be used during subsequent stages of the Lake Ontario Shoreline Protection Study.

An interdisciplinary study approach is best accomplished by a planning team which employs a diversity of professional skills. This approach does not mean that all participants must be involved in each activity, task, or

stage, only that they are involved when their skills could have a material effect on study progress and output. During Stage 1, a planning team from Buffalo District staff was utilized. It included a study manager, a terrestrial ecologist, an aquatic biologist, a sociologist, an archeologist, an economist, a coastal geologist, and a hydraulic engineer. The efforts of Corps personnel were augmented with the services of Contractors, and the input by U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation.

The study has been coordinated with various international, Federal, State, regional, and local agencies and organizations, and the general public. Information, data, and views of various agencies with varied expertise have also been solicited. Two committees have been established to provide input to the study. The first is the Interagency Coordination Committee representing various Federal, State, regional, and local agencies. The second is the Citizens Advisory Committee representing the riparian and recreational interest of the study area. These committees were established during the latter part of Stage 1, and therefore have had no input to Stage 1. There first contribution will be through their review of and comment on this report.

The services of an Architect/Engineer (A/E) firm will be contracted to conduct the remainder of the study with the exception of fish and wildlife studies. These latter studies will be conducted by the U.S. Fish and Wildlife Service under an Interagency Agreement. The A/E firm, Normandeau Associates, Inc. of Bedford, NH, was selected using Department of Defense procurement procedures. The firm was judged to be the best overall of the 26 prospective firms which responded to a Commerce and Business Daily advertisement. The selection criteria emphasized interdisciplinary expertise and experience. The Contractor will be required to continue the interdisciplinary approach of the study.

Public Involvement

It is the policy of the Corps of Engineers that civil works projects, under authority of the Corps of Engineers, be conducted in an atmosphere of public understanding, trust, and mutual cooperation. This is accomplished through actively involving the public in water resources studies by opening and maintaining channels of communication.

To provide the needed expertise for implementing an effective public involvement program for the study, the service of a public involvement Contractor was procured. Through the Corps procurement process the best firm, Great Lakes Tomorrow, was selected. With the emphasis on identification and definition, rather than resolution, public involvement was directed towards insuring the articulation of a wide variety of viewpoints and concerns so that they could be considered in the planning process. The contract was accomplished in two phases.

The first phase emphasized identifying public concerns and problems associated with Lake Ontario, its shoreline, and the study. Previous public involvement efforts were identified and reviewed. Public interest groups were identified for purposes of establishing a mailing list. An information brochure was developed describing the study, the role of the public, the study process, issues such as lake level regulation and public concerns from previous public involvement efforts. Facilitative workshops were held at five locations along the shoreline during 6-9 August 1979. Four were oriented to the general public and held during the evening. The fifth was held during the day for accessibility by agencies and elected officials. Following the workshops a "feedback" brochure was developed and mailed to the workshop participants summarizing the results of the workshops.

Phase 2 was oriented to assessing impacts of possible measures to be investigated during Stage 2. Two information brochures were developed prior to the five workshops which were held during the week of 23-27 June 1980. As

during the first phase a "feedback" brochure is being developed. Results of this second series of workshops will be provided in the Stage 2 report.

Recommendations from the public on how the public involvement program should be structured were sought by questions on the workshop registration forms, and in those workshop sessions where time permitted. The public provided input on such things as which public interest groups should be involved in the study, appropriate methods of public notification and involvement, as well as who would conduct future programs. Information requirements for review of alternatives and means of response were included.

Based upon this input and the recommendations of Great Lakes Tommorrow, the following is a discussion of the public involvement program for the remainder of the study.

First of all, it should be reiterated that the Buffalo District intends to actively involve the public throughout the Lake Ontario Shoreline Protection Study, and is committed to providing a public involvement program which serves both the purposes of the study team and the public. A program that essentially makes the public a part of that team, but still recognizes their different needs.

Future public involvement efforts will be a continuation of the program utilized during Stage 1 and will provide a progressive educational effort.

About 300 individuals and groups were identified as interested parties through attendance at workshops or through mailed returns and form an obvious base of participation. Third party identification through questionnaires and workshop responses produced both useful categories and many specific agencies and organizations. In the past, local officials and environmental groups have had limited representation at workshops. Therefore, specific and more active attention will be given to these groups. Identification of public interest groups will focus on including those who may gain or lose economically, those affected by alternative plans, and groups whose patterns

of activity or perception of values would be changed in some way. These groups will be incorporated in future mailings to locate specific representation.

The information/education aspects of the public involvement program must be structured in full recognition of the complexity of shoreline processes, the varied nature of the land/water interface, and the limited information available to the public. The groups which have been identified will be approached with newsletters or "fact sheets" which will identify opportunities for involvement. The newsletters will serve as the centerpiece of the program and they will focus interest, provide continuity, establish linkages among the various interest groups, as well as furnishing a vehicle for reporting study developments, calendared events, and progress reports. These newsletters will utilize a multipage format and be written in laymen's terms. Opportunities for return comment will also be provided. The news media will also be utilized to augment this information/education process. Press releases will be furnished on coming events and news articles will be provided on pertinent subjects. The Interagency Coordination Committee will be utilized as a forum for providing briefings to related agencies to provide for their meaningful input.

The Citizens Advisory Committee will be utilized as a "sounding board" for riparian and recreational views and concerns. Briefings and detailed information will be provided to the committee to assist them in providing more knowledgable input to the study than could be gotten from the general public.

Study reports, such as this Reconnaissance Report, and the Preliminary Feasibility Report and the Final Report at the ends of Stages 2 and 3 respectively, will be made available to the public through limited distribution. Draft reports will be provided to select agencies and the two study committees for their review and coordination. It will also be placed in community and university libraries and Federal depositories to enable access and review by the general public. Following a formal review period, a

public hearing will be held, whereby public evaluation of the reports will be possible. Incorporation and/or address of comments and criticisms will be incorporated into the final Reconnaissance Report. This report will be placed in libraries for reference by the public throughout the study. The public will be notified as to the locations.

Facilitative workshops will continue to be used as the primary means of soliciting public input to the study, although they will be augmented by interviews with agencies and the public, and by way of correspondence.

In determining who should conduct the public involvement program, several considerations were taken into account. These were:

- Expertise in conducting public involvement programs.
- Capacity for conducting continuing public education.
- Objectivity and established credibility.
- Skills in communicating and interpreting technical issues/information.
- Access to local, regional, and basin-wide public interest groups; knowledge of regional issues.
- Capacity for concurrent analysis of study products.
- Knowledge of associated technical, institutional, and system factors.
- Capability for policy analysis.
- Potential access to Canadian public interest groups.

Realizing that no one entity could readily meet these considerations, a division of functions among Corps in-house staff and appropriate outside sources was necessary. The use of an appropriate outside source, such as Sea Grant, or the Coastal Zone Management Program, would be appropriate in providing technical information/education programs to local groups. Shared program responsibilities may also be possible. The use of a neutral third party to conduct prehearing briefing sessions will be used. Facilitative workshops will also be conducted by a third party, preferably one who is trained in the necessary public involvement techniques such as a Contractor, agency, or organization. A technically qualified source will be utilized in developing and preparing information for newsletters and the media in order that the information is provided in a clear and concise manner, and presents all the relevant issues. If Canadian coordination becomes more actively pursued than is presently allowed, the use of an appropriate agency or organization will be necessary. Corps personnel will be used to manage the program so that it is timely and coordinated with the overall study. Staff will be utilized as a resource base to all aspects of the program.

During Stage 2, the Contractor, Normandeau Associates, Inc., who will be conducting Stage 2 study efforts, will also be responsible for the public involvement program. This will include information materials and workshops. Educational programs with other agencies will be pursued by the Corps staff.

Environmental Impact Statement

An Environmental Impact Statement (EIS), as required by Section 102(2)(c) of the National Environmental Protection Act, will be prepared in conjunction with the study report. The EIS will be an integral part of the interdisciplinary plan formulation process and will serve as a summation and evaluation of the effects, both beneficial and adverse, that each alternative action would have on the environment. It will also serve as an explanation and objective evaluation of the finally recommended plan.

The environmental statement will fully discuss the primary and secondary environmental effects including the social and economic impacts of the various alternative plans. The interdisciplinary environmental investigations carried on throughout the study and leading to the preparation of impact assessment and EIS will be undertaken simultaneously with, and to the same depth and scope as study related engineering, economic, and technical studies. The EIS is considered as an integral part of the study planning process and as such, is one of the documents upon which a decision on a Federal action is based. It will be written so as to substantively stand on its own and will be submitted, as an integral part of the Final Report, for review by the public and other governmental agencies.

The first document prepared during the development of the EIS is the Summary of Environmental Considerations (SEC) and will be a part of the Preliminary Feasibility Report (PFR) at the end of Stage 2 - Development of Intermediate Plans. The SEC is a summary, based on information developed in the study related environmental inventory or baseline studies. The SEC will be attached to the announcement for the public meeting at the end of Stage 2 in order to facilitate meaningful and thorough discussion during the meeting. The SEC will be updated throughout Stage 3 - Development of Detailed Plans and again presented for discussion at any public meetings held during this stage.

At the end of Stage 3, a Draft Environmental Impact Statement (DEIS) will be prepared and circulated for review and comment as a part of the Draft Final Feasibility Report (DFFR). It will present and discuss the anticipated environmental effects of the plan which may be recommended by the District Engineer along with the probable environmental impacts of the alternative plans considered in the study.

Once comments have been received and addressed, and any revisions to plans or plan selection are made, the Final Feasibility Report (FFR) and Environmental Impact Statement are prepared addressing the final study recommendation. These will then be sent to higher authority to serve as the

decision documents for ultimate recommendations to Congress. Following review and comment and just prior to forwarding to Congress, the final EIS is prepared addressing the recent comments.

Technical Studies Required

Stage 2 of the Lake Ontario Shoreline Protection Study will focus on the development of a broad range of alternative plans to meet the planning objective. The purpose of Stage 2 is to screen these plans by carrying out sufficient iterations of the four planning tasks (see Section 1) to decide which plans, if any, warrant more detailed study in Stage 3. In addition to the formulation of plans, and to lesser degree, the other planning tasks, technical studies are conducted to support the activities which are done during the planning tasks and to assist in directing more detailed studies during Stage 2. These technical studies are as follows:

Environmental Studies

. Pilot Baseline Studies - Two pilot wetland areas have been selected for detailed investigation during Stage 2. The purpose of these studies is to gather baseline data of two selected wetlands, Campbell Marsh (Jefferson County), and Sage Creek Marsh (Oswego County), and using this data, to develop a model which will correlate key wetland descriptors and lake levels. Methodologies and studies will be developed to facilitate future systemwide investigations and evaluations during Stage 3. These Stage 2 studies are divided into two phases. The first phase which was started in August 1980 will include 1-foot contour mapping of the wetlands and offshore areas, vegetation mapping, vegetation survey, data analysis, and a report, and scoping of Phase 2 studies. Phase 2 will focus on investigating benthic invertebrats, fish, reptiles, avifauna, mammals. The selection of sites and development of the scope of work for these studies was done by USF&WS in consultation with NYSDEC and the Buffalo District. Field studies are being done by USF&WS with assistance from Corps personnel and in consultation with NYSDEC.

. Cultural Resources Predictive Model Survey - In accordance with the National Historic Preservation Act of 1966, NEPA, Executive Order 15593, Procedures for the Protection of Historic and Cultural Properties (36 CFR, Part 800), and Identification and Administration of Cultural Resources (33 CFR, Part 305), a study of the cultural resources of the Lake Ontario and St. Lawrence River shoreline has been initiated. This study is being conducted jointly with the St. Lawrence Seaway - Additional Locks Study. The study will inventory known architecturally significant, historical sites, and known submerged cultural resources sites. A model will be developed to predict archaeological sensitivity of the area.

Economic Studies

. Economic Correlations - To perform an economic analysis of shoreline protection for a specific area, benefits are derived from damage prevented. During Stage 1 such an analysis was performed using some simplifying assumptions. The assumptions generally gave a liberal representation of the damages. For Stages 2 and 3, the analysis must become more exacting. Thus, a better correlation of damages is necessary. An analysis of market values of property along Lake Ontario will be performed with a view to providing a relationship between setback and property value. This will provide a depreciation function for use in determining the depreciation of property value over time due to erosion. A functional relationship will also be developed to correlate structural damage on homes due to wave attack. Such a relationship will correlate wave height, first floor elevation, setback, and structure value.

Engineering Studies

. Critique Existing Regulation - This item of work will be accomplished by the Stage 2 Contractor. It will consist of reviewing past regulation of Lake Ontario with a view to determining where changes thereto could be made and whether past regulation should have been different. This latter item will be based upon information which was available to the Board at the time and not on hindsight.

. Hydrologic Analyses - Considering both deterministic and stochastic techniques for assessing hydrologic variability, existing and alternative regulation plans will be developed and evaluated on the basis of recorded historical sequence of supplies, levels and flows and on the basis of statistically compatible simulated sequences of supplies, levels and flows. The two methods will be compared as to their results, applications, costs, and reliabilities.

. Mathematical Representation of Levels and Flows - A method for representing the interrelationship of the levels and flows of the Great Lakes, and their relationships to causative factors will be developed. These factors will include natural factors such as meteorology, hydrology, and hydraulic characteristics of the Great Lakes watershed, as well as artificial factors such as existing or proposed constraints on the regulation of levels and flows. The representation (mathematical or computer model) shall be capable of determining, based on input constraints, the regulation plan which would optimize the combined effects on all affected interests. The model will be capable, also, of assessing the benefit/disbenefit of regulation plans on the affected interests.

Other Studies

. Institutional Study - This study was initiated in June 1980 and was to conduct and document an analysis of the institutional infrastructure of the Lake Ontario shoreline. This included the identification of institutions, both agencies and authorities, pertaining to planning, assistance, and regulation functions with primary focus on the implementation of nonstructural measures. Also included is an analysis of judicial interpretation of existing authorities. Recommendation resulted for subsequent study development to improve the analysis and presentation of institutional arrangements. The study was completed in October 1980.

Policy Issues To Resolve

Under existing beach erosion control laws, Congress has authorized Federal participation in the cost of restoring and protecting the shores of property on the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and lakes, estuaries, and bays, directly connected therewith. Federal participation is based on the shore ownership, use, and type and incidence of benefits. If there is no public use or benefit, Federal funds can not be used. Thus, for privately-owned property, there is no cost sharing, unless there is a public benefit.

This is contrary to the Federal interest in cost sharing of flood control projects. On the Great Lakes, the Federal interest in protection from flooding is not explicitly defined by legislation, but has been defined by precedent authorizations at 70 percent of the first cost of the protection. In June 1978 the President proposed that cost sharing for this type of protection be modified to require a cash or in-kind contribution by the non-Federal interest equal to 20 percent of the project investment costs. There are no restrictions regarding shoreline ownership or public benefit for lake flooding. Thus, for Lake Ontario, there is a Federal interest in and cost sharing available for protecting the shoreline from damages due to wave caused inundation, but not for damages resulting from erosion which may in fact be caused by the same waves.

The study authorization directs that the study report to Congress shall contain proposals for equitable cost-sharing. This has been interpreted to mean that the study is to evaluate the present Federal interest in shoreline eorsion and flood protection and determine whether present Federal policy thereof is equitable. Because of the National ramifications of this policy issue, its resolution must be accomplished at the Washington, DC level. It is proposed that the determination of who will conduct this aspect of the study and its methodology will be accomplished during Stage 2 and any required studies, such as incidence of benefits, and determination of policy be accomplished during Stage 3.

CONCLUSIONS AND RECOMMENDATIONS

As a result of the analysis of the problems, needs, and opportunities of the Lake Ontario shoreline within the United States, it has been determined that the damages resulting from erosion and lake flooding are severe and widespread. It has also been determined that there are methods for alleviating such damages, and there appears to be economic feasibility of some of those methods. In view of these determinations, other related problems and needs, and the support for the study by the State of New York, other agencies and the riparian land owners, it is concluded that further study is warranted.

It is recommended that this Reconnaissance Report be approved and Stage 2 of study development proceed.

GEORGE P. JOHNSON
Colonel, Corps of Engineers
Commanding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